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The relationship between modern land use and surface finds

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The relationship between modern land use and surface finds

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Statement of Authorship

I hereby declare that I am the sole author of this bachelor thesis and that I have not used any sources other than those listed in the bibliography and identified as references. I further declare that I have not submitted this thesis at any other institution in order to obtain a degree.

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1. Introduction

1.1. Landscape. Types of landscapes. The study of landscapes begins with attempts to delimit what the term „landscape“ signifies. In common usage, the term „landscape“ means a visual perspective and perception on the land (Calhoun 2002, 261). A question that seems easy to answer and a concept that at a first glance is intuitively comprehensible, actually remains rather ambiguous (Johnson 2007).

There is a problem with defining two different groups of meanings of the term “landscape” in the scientific discourse. On the one hand, we talk about the geological or natural landscape. On the other hand, speaking of the landscape, we mean the complex of anthropogenic traits that present changes or corrections made by human beings and superimposed on this natural landscape like a thin veil on a solid base (Kluiving 2012, 11).

Landscape was traditionally understood as the whole of biotic and abiotic components, which predetermine the mechanisms of behavior of living organisms in their habitat. Most geographers saw human activities in the landscape as dictated by its physical properties. According to some theories, landscape do not have its own regularities or dynamics, but have only been influenced by all their components (Gojda 2000, 61).

By the end of the 20th century, the concept asserting theory of human impact on different natural landscapes since the ancient past had become more common, and gradually humans have become the dominating force shaping the landscape of many regions. Nowadays, landscape biologists and ecologists tend to see a deep involvement of human roles in the landscape development and preservation (Kluiving 2012, 12). They consider landscape more like a long-standing phenomenon (Beneš – Brůna, 1994). That means that landscape due to human activity became a repository of material and non-material traces of human activity, which is partly reflected in the concept of the landscape memory (Gojda 2000, 61-62).

1.2. Cultural landscapes. Within such a complex understanding of the landscape notion, there have always been attempts to classify different types of landscapes. In the field of archaeology, the most common one is a vision of natural and cultural landscapes as two opposing aspects (Gojda 2000, 63).

Cultural landscape, as its name suggests, is affected equally by the natural forces and human activities and displays undeniable influence of the human factor. The first mention of the term “cultural landscape” appears in the 1920s at works of the American geographer Carl Ortwin Sauer (1889-1975) and implies both the modern day landscape and all the past landscapes modified by man (Šimůnek 2018, 16).

This division into natural and cultural landscapes was highly debatable in the 1990s. Most authors were opposed to such a strict separation of the terms, supporting the opinion that the landscape phenomenon is much more complicated and the landscape itself consists of interfering mutual influence processes of natural components and human activity. According to these theories, there is no special need to separate the natural and cultural landscapes (Gojda 2000, 63).

But viewed from the other side, the distinction of these two types of landscapes helps scientists to identify boundaries between the different types of formations with their own inner dynamics and to help different fields of study to solve scientific problems. Therefore, the argumentation for the necessity of analytical separation of landscape types is convincing. In that way, the only problem that we face is the problem of appropriate definitions of terms.

In all duration of the landscape archaeology theoretical development, we meet such terms as "buried, archaeological, prehistoric or historic landscape" with varying frequency (Bradford 1949; Whimster 1989; Kuna 1991; Darvill et al. 1993; Bewley 2001; Rippon 2012; Johnson - Ouimet 2014). However, their content is not always clearly defined or specified in the scientific community. C. O. Sauer provided the vision of equality between terms „cultural landscape" and „historic landscape". He refused the need to distinguish between these terms. His opinion stood on the premise that even modern landscapes are not static; they are continually changing in time. So in that way it becomes very hard to determine the line between "historical" and "modern" cultural landscape. Indeed, there can be no understanding of the dynamics of the contemporary landscape without study of its development in the past (Sauer 1941).

Nowadays, a widely supported statement goes that almost all modern landscapes, in one way or another, feel the influence of human activity and that the concept of "virgin nature" does not exist (Gojda 2000, 63). Unfortunately, these statements do not solve the problem, but rather complicates it. Among other issues related to this term, we should acknowledge that there are profound geographic differences in use of the cultural landscape idea (Head 2010).

Nevertheless, for the scientific practice and work on particular projects it is important to allocate adequate term descriptions for the related research problems and their methodological solutions. In the case of this BA thesis, the solution of problem connected to terminological ambiguity might lay in the definition of "cultural landscape" as a "cultivated landscape". Thus, the landscape type under our investigation could be defined as a landscape that has undergone changes in the course of directed human social and economic activities. In this study, it means primarily the landscape adapted through millennia of practiced cultivation to serve the purpose of agricultural production.

1.3. The concept of palimpsest. In modern European archeology of the landscape, there is widely shared concept of understanding the landscape as a "palimpsest". That beautiful and accurate metaphor originated from the work on historical geography named "Domesday Book and beyond: Three essays in the Early History of England" written in 1897 by English historian and lawyer Frederic William Maitland (1850-1906). In his work, F. W. Maitland calls the landscape a "marvelous palimpsest". Inspired by the book of F. W. Maitland, British landscape archaeologist and the founder of aerial archaeology Osbert Guy Stanhope Crawford (1886-1957) used the term "palimpsest" in his book "Archaeology in the field" in 1953 and popularized it. He described broad landscapes of Britain as "a document that has been written on and erased over and over again" and noticed that "it is a business of the field archaeologist to decipher it" (Turner – Fairclough 2007, 127).

The successful description made by F. W. Maitland found such a deep response among the landscape archaeologists, because the landscape contains and remembers, albeit with a varied longevity, all human intervention into it from the beginning of times when people started to change landscapes (Gojda 2000, 55).

1.4. Relationship between settlements and landscape. Today, with the help of other cooperating sciences, we can detect and recognize most of those elements in the landscape, which are connected to human activity. The number of anthropogenic elements and their complex relationships on such a „palimpsest" is enormous. The easiest-to-detect elements, without doubt, are immovable artifacts, such as buildings and various structures related to settlements, such as earthworks, earth embankments, etc. The determining factor of their visibility is the size of these features. The more monumental form of a feature, the higher chance to recognize its presence in a studied landscape and understand correctly what we see (Aston 2014, 11). Some of these elements are quite evident in the landscape, but some of them are not so obvious. So the landscape archaeologist uses methods of the natural sciences that help to capture traces of human impact or patterns which are recorded in the landscape through the centuries. All these patterns contain information about human behavior in the past and reflect a long-term iterative character of processes of land use.

A useful approach that helps to get a fuller picture is to study landscape in a broader spatial context. Analysis of large areas allows us to find a greater number of regularities or relationships between the landscape and human activities in their mutual development.

We can classify traces left in the landscape on the basis of human activities typology. According to Evžen Neustupný's theory of settlement areas (Neustupný 1986), human activities can only be investigated in the places where they were carried out. If there was any activity realized, it took place at a certain location. It follows that all the space utilized by human communities is divided into certain activity areas (Neustupný 2007). The union of all particular areas where human activities take place is called a settlement area (Neustupný 1986, 226-227).

Between them there are obviously are elements belonging to a residential area, which is the central area of human activity through the time of all humankind existence (Neustupný 1986, 227). Most of them could not be explicitly indicated in modern landscape because of the short lifetime of the perishable materials from which they were constructed. Between them, we can name for example wooden constructions of houses.

So-called storage areas represent another component of most settlement areas. This is a very important component of agricultural settlements. By this term we typically mean a space designed for food storage, alternatively storage of raw materials or finished artifacts meant for future use. Storage areas are represented by underground pits for grain in many prehistoric periods and in the early medieval period, and various above-surface constructions and specially constructed buildings (granaries) located in residential areas typical for later historical periods. Fodder storage for winter period forms an integral part of storage area within settlement areas (Bouzek et al. 1966; Neustupný 1986; Vařeka 2003).

Other critically important areas for any community were production areas. The production area was the place where people could obtain subsistence, nourishment needed for survival. For communities of hunters and gatherers this role has been provided, consequently, by hunting and gathering areas. For agricultural communities, such places were primarily arable fields and pastureland. To these main production areas we need to add places, where people obtained animal fodder as well as areas where they collect forest fruits, honey and mushrooms. With an increasing degree of specialization during the prehistory, we can find more frequently designated areas of craft production, such as stone working, pottery making or metallurgical activity (Neustupný 1986; Smrž 1995; Hložek – Menšík 2013).

Ritual areas that evidently had great symbolic meaning for every type of human societies stand apart from the above-mentioned activity areas. They do not always have an unambiguous association with a concrete place or such place might be hard to recognize in the archaeological record.

Last but not least, we should mention roads and pathways, as important components of any inhabited landscape. Their role was to connect all other activity areas, as well as different communities.

1.5. The definition of land use. All anthropogenic changes of the landscape that occurred throughout human history have been closely related to the way people use the land.

Michael Aston in his book "Interpreting the Landscape" offers an accurate definition of land use in archaeology. "Land use is therefore a central theme, with discussion about how land has been used at different times, what field systems have been employed, and the ways of operating them, and how these patterns have changed through time" (Aston 2014, 11).

In this way, he outlines the main problems of study on land use, which landscape archaeologists usually try to investigate. Typical questions include, firstly, how old is the field system we see in a particular cultural landscape? Secondly, are the patterns visible in the landscape the oldest ones or were there any predecessors? Thirdly, if there are no apparent traces of archaeological components on the landscape surface (crop marks, soil marks or earthworks), could we still find out something about what the landscape looked like in the past? (Aston 2014, 103).

In European regions, traditional land use strategies can be divided into four main categories: arable areas, where crops are grown, pasture, where animals grazed, meadows for producing winter fodder, and woodland to provide wood and timber (Aston 2014, 103). Thus, we have four main vectors to study regularities in the cultivated landscape. In our study, we will try to consider all these types of land use in the concrete small region and reveal its information potential for our understanding of historic landscape.

1.6. Purpose of the thesis. One of the main aims of this study is to examine the relationship between the distribution of ceramic material detected on modern arable fields and past land use. If any patterns and regularities can be observed in the collected data, we will look into possible factors that might have formed them. Our expectation is that the spatial structuring of surface finds may be linked to the historical tradition and temporal development of land use in the investigated area. The configuration of field systems connected to built-up areas (villages) could be a significant determinant of surface finds densities. Furthermore, the variability of spatial behavior typical for different chronologically sensitive pottery classes might become an important indicator of landscape changes over time. Finally, our attention will be turned to the question, if different farming regimes (i.e. traditional vs. modern) can be detected through the study of surface collection of artifacts. This research direction should lead us to the final assessment of plausible historical reconstructions of the cultivated landscape.

2. Methods

2.1. Landscape archaeology methods. The main sources helping to understand the history of particular landscapes, after Michael Aston, are archaeology, aerial photography, maps, local history and related studies (Aston 2014, 13). Mark Bowden has a similar opinion as he names among the main disciplines helping to unravel historic landscape archaeology, historical geography and local history (Bowden 1999, 13). And the most useful sources of landscape study after Bowden are those that gives us „direct or indirect topographical or visual access to the field remains“ (Bowden 1999, 33). In addition, this author points to the three most efficient methods of landscape survey, which include aerial reconnaissance, geophysical survey and surface collection of artifacts („fieldwalking“). The advantage of aerial prospection lays in its ability to see the terrain from a broad perspective, that provides us deeper understanding of all the changes taking place in the process of human activity (Bowden 1999, 107, 119).

2.1.1. Historical geography. In the study of forms and changes of the cultural landscape a common source of information are some types of written archival documents containing descriptions of the landscape in the past.

The oldest of them (charters, annals and chronicles) often contain fragmentary information about the shape of the landscape; they mention settlements in a particular region, roads, and forests. The most common sources for the landscape research, however, are cartographic documents. Cartography provides indispensable resource to the field of landscape history.

Historical maps give us clues for reconstructions of the original medieval landscape, based on the traditional form of cultural landscape in the 18th to 20th centuries. Cartographic sources from this era help us to trace the relationship between the cultural and natural landscape, determine the percentage of arable land and the size of fields, pastures and meadows, track changes in water regime, road network, forest area and much more (Gojda 2000, 100-101).

However, when working with cartographic sources, it is worth considering that none of them was created directly to meet the needs of future archaeologists. Every map served a specific purpose, typically defined by a person or institution that ordered and paid its compilation and drawing. When working with these sources, one must take into account their historical or geographical context. Also, older maps may contain inaccuracies due to imperfect mapping methods in the periods of their origin. It is best to work with such sources through assistance or consultation with experts from the relevant field (Bowden 1999, 36-37).

2.1.2. Archaeology. Previous investigations. Significant sources of information in the very beginning of any archaeological research must be records of known previous investigations or excavations carried out in the area of interest. It helps to take into account all the types of archaeological sites or field monuments that have been found in the extent of the researched area and to "map" in mind the perspective of the landscape formation that an archaeologist works with. As definitely useful and among the highly recommended records Michael Aston names early pottery collections, even if they were obtained by amateur collectors without any professional skills. Such records can indicate new sites or may help to determine the beginning or base point of our own field research. References to previous excavations, especially if they have been accompanied by reports of cooperating natural sciences or disciplines, help to indicate landscape transformations in past periods of time (Aston 2014, 13-14).

Surface collection of artifacts. Between archaeological methods of studying the landscape, the method of surface collection has proven itself as very successful and effective. Collecting of finds during fieldwalking has been known as an established archaeological technique since the late 19th century. It gives an opportunity to address a number of research questions cheaply, without the use of destructive methods of archeological excavation (Redman 1987, Kuna 1998). Its origins lie in the19th century with a so-called "flint hunt" described and motivated by General Pitt Rivers. This trend was influenced by the rising interest of scientific community about the prehistoric past and this curiosity needed numerous artifacts to build at that time still missing typologies of ancient material culture and to organize the collected finds in typo-chronological schemes.

In Europe and both Americas this technique was taken systematically only from the 1940s and onward. In Great Britain the fieldwalking had become extremely popular in late 1970s and 1980s and led to numerous publications on the theory and methodology of this approach, which now constitute the detailed core of this method in British archaeology. Fieldwalking started to become a tool that helps to reveal location and character of past human activities in the landscape (Bowden 1999, 125). This methodology has been increasingly accepted as a basic approach to archaeological landscape survey in many European countries (Bintliff et al. eds. 2000). Some authors stressed the necessity of developing a specific theory to map and critically interpret various traces which can reflect past of human activities (Neustupný 1993).

The clear advantage of fieldwalking however lays in its ability to conduct a survey with any number of people of any level of experience and with a minimum of equipment (Bowden 1999, 125). This approach to landscape archaeology is also an adequate training activity for university students, who can learn many practical skills during fieldwalking, namely navigation in open landscape, recognition of various types of artifacts and their small fragments, record keeping and handling various weather and terrain conditions. The data analyzed in this bachelor thesis originated in precisely this type of university project, which combined research and educational motivations (Šmejda 2003; Chytráček – Šmejda 2005).

Surface collection of artifacts is a useful source of information for exploration land use. Because most of the sherds were scattered on the fields during soil fertilization together with manure, collections of surface finds can be used as a source of information about the traditional use of land (Jones 2004, 162).

Methods of surface collection of artifacts. The main objectives of this technique are a) discovery of new sites, b) mapping of an archaeological potential in some area of interest for its subsequent investigation by excavation, and c) the research targeted at specific theoretical problems. Recently, the role of using surface collections as a way to tackle theoretical research questions independently from the more traditional archaeological methods has been gaining importance. This methodology has ceased to be viewed merely as an auxiliary approach or preliminary stage of archaeological excavations, but is regarded now as a full-fledged and independent form of archaeological research (Kuna 1994).

No single and universal set of instructions for conducting surface collection of artifacts can exist, because this approach includes a wide range of research methods varying in accordance with the goal of survey, local topography, chosen sampling design etc. Moreover, each project integrates today several approaches to archaeological survey, and this interdisciplinarity usually dictates some parameters of the fieldwork as well. In the end, several datasets of different types are combined and studied, typically in geographical information systems, and this requires some degree of standardization and compatibility of contributing methods of data collection, storage, manipulation and analysis (Gillings 2000).

Today, analytical approach to surface survey is generally preferred over the more traditional synthetic or interpretative approach. By the analytical method of surface collection we understand the fieldwalking of selected polygons, which usually correspond to individual arable fields, and also the chosen method of dividing these polygons into the most basic survey units, using a pre-defined system of walking lines, sectors and/or other elements, aiding the documentation and mapping of finds. Among the main strategies of surface finds collection we can name a) a simple synthetic method of searching for new sites, b) collecting in polygons, c) collecting in lines, d) collecting around selected points, e) collecting inside a network of squares, g) crossover passage, h) mapping of individual artifacts. For each of these schemes of fieldwork, several parameters of the overall survey design should be set to control the intensity and standardization of sampling (spacing of survey units, searching time spent in a single unit, recording field conditions like weather, state of soil and vegetation etc.). M. Kuna describes these aspects in detail in his publications dedicated to this problem (Kuna 1994; 2004).

Regardless of the collecting strategy chosen in individual projects, results of surface collection normally appear in some kind of density map, reflecting the spatial distribution of artifacts in the study area (Kuna 1994, 10-11). The significance of individual finds discovered by this method of surface survey cannot be determined and evaluated in the field. The creation of analytical maps and consideration of topographical context of find densities, together with taking into account other factors influencing the results, are crucial steps in the whole process of landscape survey and interpretation (Bintliff et al. eds. 2000; Chapman 2006).

2.1.3. Remote sensing. In archaeology, there are several landscape prospection technologies falling into the category of remote sensing. They include aerial photography, satellite imagery, geophysical prospection, and today increasingly Unmanned Aerial Vehicles (UAVs, drones). Instruments mounted on various types of platforms have contributed enormous volume of data for the discovery and mapping of archaeological sites and historic landscapes in many different environments. This trend is well documented in the steadily growing number of publications on this topic (Agapiou - Lysandrou 2015; Gojda 2017).

Aerial photography. Panchromatic oblique and vertical aerial images have been intensively used for archaeological survey from the beginning of the 20th century, later accompanied by color and infrared photography. Aerial survey is known to be a very cost-effective form of data collection about landscapes (British Academy, 2001). Its methodology is based on the set of principles, describing how archaeological remains can reveal themselves through direct and indirect surface signals (soilmarks and shadow marks as direct, cropmarks and snow marks as indirect signals). Both oblique aerial photographs taken typically by archaeologists themselves using hand cameras, and vertical photogrammetric photographs, requiring professionally equipped survey aircraft and skilled personnel, play important and complementary roles in landscape archaeology (Šmejda 2017).

Another advantage of aerial archaeology is the existence of large collections of archival images, spanning a century of practicing of this type of survey (Hanson 2012). These archives can provide valuable information about the changing environment and land use over time. In our case study, results obtained from the surface collection of Modern-period pottery fragments will be compared with the state of agricultural land segmentation in the pre-collectivization period. Historical photographs several decades old can be a valuable source of information about past water networks (especially small streams or former river meanders) that have disappeared in the course of ongoing landscape transformations (Kuna 1994, 14).

LIDAR. More recently, new airborne sensors such as Airborne light detection and ranging (LIDAR) or Airborne Laser Scanning (ALS) have opened new ground for the investigation of archaeological landscapes, especially in forested areas. This technology has significantly expanded our understanding of anthropogenic terrain relief and its preservation in many countries (Bewley et al. 2005; Doneus et al. 2008; Evans 2016). The rapidly growing body of knowledge emerges from sophisticated processing methods of LIDAR data, which make efficient analyses and visualizations of Digital Surface Models (DSMs) or Digital Terrain Models (DTMs) largely available.

LIDAR allows the identification and very time-efficient recording of geomorphological features on the ground with sub-metre accuracy. LIDAR operates on the principle of measuring the time taken for a pulse of light to reach the target and return, which is directly proportional to distance. Airborne LIDAR scanners use a pulsed laser beam that hits the ground below the aircraft‘s path in a zig-zag pattern, measuring up to 100 thousand points per second. This produces an accurate, high-resolution point cloud model, representing the ground relief and the features upon it. The accuracy of the elevation measurements allows for recording features that may not be visually identified during foot survey or on aerial photographs (Crutchley 2006).

Some advanced laser scanning systems provide, in addition to 3D position of measured points, information on the intensity of the recorded signal or in some cases also its amplitude, and these parameters allow for automated sorting and filtering multiple echoes within one pulse and differentiate signals returned from tall and low vegetation, ground, and other types of surfaces.

Digital elevation models (DEMs) produced by LIDAR can be studied in many computer applications, among them in various geoingeneering software tools and Geographical Information Systems (GIS). They can be illuminated from arbitrary directions to produce hillshade models of the ground relief (Devereux et al. 2005), other processing methods use colored hypsometric elevantion maps, computation of local relief maps ort he so-called Sky View Factor (Gojda – John 2013). The combination of techniques that help avoiding the directional problems of traditional hill-shading models extended a range of applications in archaeological survey, even in areas with very complex geomorphologies (Devereux et al. 2008).

Some terrains still remain more difficult for lidar survey than others. Among the factors that can have a negative impact on the capability of LIDAR to record microtopographic details with high resolution are steep slopes and big differences in heights and density of vegetation cover (Corns - Shaw 2009).

Satellite imagery. Landscape archaeology can use a broad range of data provided by sensors mounted on orbital platforms (satellites). They use various parts of electromagnetic spectrum for remote sensing of the Earth, including those that are not perceptible by human eye (such as radar or infrared wavelengths). The early satellite reconnaissence missions used traditional film cameras, while modern systems are fully digital and capturing images in many spectral bands (multispectral or hyperspectral sensors). Satellite remote sensing in archaeology requires special treatment of data (Fowler 1994) and only exceptionally (and on the commercial basis) offers spatial resolution necessary for the case study presented in this thesis. Therefore it will not be discussed in a greater depth here, but we do acknowledge a large potential of satellite imagery for archaeology in many other research contexts (Custer et al. 1986; Masini - Lasaponara 2007; Casana - Cothren 2008; Parcak 2009; Lasaponara – Masini 2011).

Unmanned aerial vehicles. Drones or UAVs (Colomina - Molina 2014) are regarded today as the next valuable addition to the archaeological remote sensing toolkit. Their relatively low cost and high resolution data have already started a new era in archaeological surveys (Nikolakopoulos et al. 2017).

Geophysics. Geophysical surveys are also considered a part of remote sensing techniques, having been utilized in archaeology for many decades (Bowden 1999, 119). Geophysical prospection is usually very precise in detecting sub-surface remains, which do not need to have any indicative marks on the surface. Different geophysical instruments (such as ground penetrating radar (GPR), magnetometry and electrical resistivity) are frequently used in tandem during investigation of studied monuments and landscape transects, combining their complementary abilities to detect different types archaeological remains (e.g.

hearths, stone walls, pits and ditches filled with sediment, hollow spaces). Geophysical methods have proven to be an indispensable part of non-destructive archaeology, with a wide array of practical applications (Křivánek 1998; Křivánek 2004; Conyers 2016). Especially when used in combination with other prospection methods, for example with aerial reconnaissance, the contribution of geophysics towards new discoveries and better understanding of archaeological landscapes is crucial (Bálek et al. 1986; Becker 1995; Becker 1996; Gojda 2004).

2.2. Multidisciplinarity of landscape surveys. As it logically emerges from all the mentioned in above, the discipline of landscape archaeology is intrinsically multidisciplinary. Any adequate study of landscape is possible only through combining methods of various specializations. Different technologies successfully cooperate in the archaeological remote sensing and in archaeological prospection in general (Ciminale et al. 2007). Their results became integrated into Geographical Information Systems (GIS) and analyzed in this kind of software packages. In our case study, we will combine the information potential of surface collecting of artifacts with aerial photography, LIDAR survey and historical maps, all these sources examined and compared with each other in GIS. This will be described in detail in the next chapter, dedicated to the implementation of my project.

3. Implementation of the project

3.1. Description of regional context and previous investigations. The presented work is based on the analysis of the collection of ceramic material collected during surface survey, conducted in 2003 and 2004 in the surroundings of the Vladař hill, Karlovy Vary district. This surface survey was led by L. Šmejda as part of an interdisciplinary project supported by the Grant Agency of Academy of Sciences of the Czech Republic. The project imvestigated settlement structures of later prehistory in West Bohemia, and one of the principal site studied in this project was the Vladař hillfort. The investigation of this extensive and complex fortification system included topographic survey, metal detector survey, geobotanical mapping, palaeoenvironmental research, archaeological excavation and aerial prospection (Pokorný et al. 2005; Pokorný et al. 2006; Šmejda 2007; Šmejda 2014). The site of Vladař yielded many important finds and contextual information from the Middle and Final Bronze Age, and especially from the Hallstatt and La Tène periods of the Iron Age (Chytráček - Šmejda 2004; Chytráček – Šmejda 2006; Chytráček et al. 2012).

This bachelor thesis is focused on Modern period pottery, collected during surveys that primarily targeted the prehistoric settlement structure. As already described above in the introduction, this recent pottery assemblage will be studied in the context of cultural landscape of the 19^{th} and 20^{th} centuries.

3.1.1. Environmental context. The investigated region lies in the rain shadow of the mountains and highland along the western border of the Czech Republic. The climate is therefore rather warm and dry here. Typical geomorphological features include conspicuous volcanic hills with flat plateaus on the top (table hills). One of them, visible with its characteristic silhouette to the long distance, is Vladař hill itself, classified by some authors as a mountain. The highest point of the Vladař hill reaches 693 m a.s.l., which is about 240 m above the Střela river, flowing around Vladař immediately on the North. The surveyed fields that yielded pottery finds for our analysis, lie between 500 and 550 m a.s.l. and are covered mostly by acidic brown soils (Chytráček – Šmejda 2005; Tomášek 2000, 53; Sádlo et al. 2008, 119-120).

3.1.2. Surface artifact survey. Fieldwalking of arable land in the vicinity of Vladař hill followed the analytical strategy of surface artifact survey. Accessible fields that were not covered by grown crops in the time of survey were understood of polygons and marked by cadastral name of its location and a letter (A, B, C), differentiating fieldwalked polygons situated in the same cadaster. Polygons were divided into a regular grid of sectors of 50 x 50 m size. Each sector was walked in 5 lines oriented N-S or S-N.

One person took care of navigation with the aid of a handheld GPS unit, where coordinates readings helped to find edges of individual sectors and ideal positioning of the lines surveyed in each sector. Students from the Department of Archaeology, University of West Bohemia walked the lines and collected all finds they could recognize on the surface. Plastic find bags were used separately for individual lines within each sector and were marked accordingly by the name of polygon, sector number, line specification, date and an acronym of fieldwalker. A paper form containing description of field conditions (weather, soil condition, state of vegetation, list of fieldworkers) was kept by the navigator for every surveyed polygon. Experience of each fieldwalker was estimated by the length of his or her involvement in practical archaeology in number of years.

Processing of finds from surface survey. Among the potential shortcomings of the survey method, we can point out that the work took place at different times of the year, often in different weather conditions and diversity of participants (according to the field documentation), often by students without proper education or relevant experience, which possibly might lead to errors in the collection of finds and their laboratory processing. Therefore, we cannot know if the amount of collected ceramics corresponds to the actual amount of sherds that was actually on the surface on the moment of collection. In some find bags we can see a higher percentage of non-artifact finds (stones), a lower percentage of small fragments and predominant percentage of porcelain and white glazed ceramics, which are clearly visible in the ploughsoil. And vice versa, in some find bags we see that the ceramic material was collected very efficiently by a person familiar with the methodology of survey and diversity of artifacts occurring in the ploughsoil.

These problems are nevertheless typical for most archaeological projects based on fieldwalking, and they can be expected to average out to certain extent by the presence of experienced and less experienced workers in the same fieldwalked sector. The processing of resulting data is based on counts of finds per sector, not of individual survey lines, so in the statistical sense the resulting counts can be regarded as comparable.

This collection of finds was provided to us by the Museum of West Bohemia in Plzeň for description and analysis, excluding prehistoric finds that originally were present in this collection. The prehistoric finds (mostly pottery sherds and chipped stone industry) were already published (Chytráček – Šmejda 2005, section 3.2) and are kept separately from the finds dated to historical periods in the Museum of West Bohemia in Plzeň. Prehistoric stone artifacts were dated to the broad interval of final Paleolithic to Eneolithic/Early Bronze Age period. The majority of indicative prehistoric pottery belongs to the Urnfield period; lesser part may date to the late Hallstatt and La Tène culture. Although the region around Vladař hill belongs to less favorable climatic zone (if compared with the so-called old settlement zone), traces of prehistoric settlements were detected in all surveyed polygons. The density of these finds was generally low, with the exception of one large concentration of finds situated 300 m to the East of Vladořice village. This site is located below a spring of fresh water that is active even today and we can deem that it was an important source of drinking water throughout all historical periods. The concentration of late prehistoric pottery fragments was conspicuous in this place (Chytráček – Šmejda 2005, Obr. 24), counting hundreds of sherds of variable sizes and a collection of pieces of burnt and partly vitrified material of unknown age. This site is regarded as part of immediate economic hinterland of the Vladař hillfort, which was suitable for agricultural production.

3.2. Historical references and analysis of written sources. The first mention of the settlements in the study area relates to the end of the 12th century. The very first data can be obtained from the "Codex diplomaticus et epistolaris (epistolarius) regni Bohemiae", where under the year 1186 the name Zlutici (nowadays Žlutice) is mentioned. The settlement that appears on the pages of written sources later than all others is Pšov, mentioned in "Registr soudu komornich D. XIII" in trial process notes (Profous 1951, 499) under the year 1513. So all the settlements under our study appear in historic sourcesy between 1186 and 1513. Of course, this cannot serve as an evidence for the fact that all these settlements actually arise at the time when contemporaries mention them. Despite this, some published codes and inventories can be used as only relatively valid set of sources to study the history and reconstruct agricultural tradition of these settlements.

3.2.1. Information about settlements. Basic references on studied settlements we found in the standard publications of settlement toponyms in Bohemia (Profous 1957, Sedláček 1998, Collective 1978). All of them give us brief information about the first mention in written sources, a way of occurrence of settlements, their known name variants (most often in German), location information, some important mentions from the history of the settlements up until the 19th century and interesting events, names of their owners and the references to further information sources. The exception is however "Retrospektivní lexikon", which provides us information on changes in settlements' status, such as merger with other settlement, joining another settlement as a suburb, subjecting to the jurisdiction of other settlement or even region, transmission or extinction. But this source is undoubtedly important for us as an instrument of correlation of a settlement with a source describing it in the required period.

Žlutice 1186. The earliest settlement testified in historical written sources in our area of interest is the town Žlutice. After the publication "Místní jména v Čechách" (Profous 1957) the first mention of the settlement refers to the year 1186. It is included in the Codex diplomaticus et epistolaris regni Bohemiae, where the settlement is called "Zlutizi". In the year 1214 this settlement named "civitas Luticz", which literally means town of Luticz (Žlutice) (Bláhová 1978; Tomas 2002). It is worth noting that from the middle of the 19th century (from 1847 after "Popis království Českého") the name of the town had been used predominantly in its German version without the first letter "Z", i.e. Luditz (Profous 1957, 859-860).

The publication titled "Retrospektivní lexikon obcí Československé socialistické republiky 1850-1970" (Collective, 1978) informs us about the town status, which for 150 years has not changed and was constantly autonomous. The only circumstance that changed during that period was its district affiliation. During years 1850-1930, it was a settlement in Žlutice district, in years 1950-1960 in Toužim district and since 1961 a settlement in the Karlovy Vary district.

Močidlec 1204. The settlement of Močidlec is first mentioned in 1204 in the Codex diplomaticus et epistolaris regni Bohemiae originally under the name "Mozidliscz" and its status was defined as "villas" (Profous 1951, 118). The term "villae" in the middle Ages means "a self-sufficient agrarian community, united farmsteads" commonly owned by monasteries (Kubelík 1996; Tomas 2002). In 1204, the settlement was owned by the monastery in Plasy. Since 1319 it had been annexed to the Rabštejn dominion (Sedláček 1998, 615).

Since the middle of the 19^{th} century (1854) in the sources, the settlement had been known as "Modschidl" (Sedláček 1951, 118). From 1850 to 1930 was affiliated to Žlutice district. After 1950 it became a settlement of Toužim district, in 1961-1970 as a part of a settlement Novosedy in the Karlovy Vary district. Nowadays Močidlec is a part of Pšov settlement in the Karlovy Vary district.

Stvolny 1321. The settlement of Stvolny is first mentioned in 1321 as "Stbolna" (Emler 1890, 294). The primary form of usage of settlement's name in the oldest sources is Stvolno. But in the middle of 19^{th} century the name was unintentionally changed to the plural by

Palacký and subsequently used in such form to the present day. In Description of Kingdom of Bohemia (Popis království českého) from 1848 the settlement is mentioned as Stwolny together with the German version Zwollen (Profous 1957, 227).

However, August Sedláček in his “Místopisný slovník historický Království českého” disagrees about the year of its first appearance in the written sources. In his work we read: “the village of Stvolny since 1319 was belonging to the castle Rabštejn” (Sedláček 1998, 846). He does not cite the original source or the original quote. Nevertheless, in the Regesta diplomatica nec non epistolaria Bohemiae et Moraviae we can find this mention in original writing related to the day 12 of August 1321 “Nos itaque Dietricus de Birda, Witco de Stbolna, Ludherus de Rabstein, Ybanus de Birssing, supra positus Hermannus de Zcedrei compromissa manu et vnanimiter sine omni falsitatis metu domino Pernoldo prius posito .. etc.” (Emler 1890, 294). In this extract, certain honorable people were listed as witnesses of the marriage of Dietricus from Birda (Brdo), where next to Ludherus (a reeve) of Rabštejn and Ybanus (Iban, a Bishop) from Birssing (Březín), a Witco from Stbolna (Stvolny) is mentioned.

Except the first mention, August Sedláček provides us with the information about the settlement’s status. The settlement was mentioned as a village. Nevertheless, under the year 1337, the village itself was deserted and its plough soils were attached to the Rabštejn dominion. The succeeding transformation of village status takes place in 1370, when Stvolno accepted status of the residence of a local parson (Sedláček 1998, 846).

For a time Stvolny settlement have changed its status several times. In 1850 it was named as a village in Manětín district, 1869-1930 as a village in Kralovice district, since 1950 – Plasy district and since 1961 until present day as a settlement in Plzeň-sever district (Collective, 1978).

Vladořice1379. Vladořice was first mentioned in 1379 as Wladorzicz in Tax list (Berní rula) of Plzen land. The name Vladořice is interpreted as a village belonging to the people of Vladoř. Since 1854, in written sources, we more often meet the spelling of Wladarz. Today the village consists of two farms.

Pšov 1513. The first short mention of the Pšov settlement we have from Archiv Český, volume 19, under the year 1513 (Profous 1951, 499). Here it was named as “Přov” in connection with the judicial complaint no. 2448 from 28th of April 1513 between Mates Hyserli and Jan from Vřesovice and at the same time as “Dobšov” in the complaint no. 2451 from 12th of September 1513 (Fridriech, G. – Teige, J. 1912, 227-229). The form of the name "Dobšov" is a kind of vernacular, dialectical name of the village, also displayed in its German forms Schaab and Schaub (Profous 1951, 499).

3.2.2. Sources for land use study. For the chosen area the fundamental and primary source that we need to consider are maps of the cadaster Stable (Franziszäischer Kataster, the Franciscan cadaster) from the first half of the 19th century. In 1817, instructions for measurements were already issued. However, the first actual mapping of settlements began to occur in 1824 in southern Moravia and the works ended in northern Bohemia in 1843. The resulting Stable cadaster maps provide detailed information for each individual cadastral district in the scale 1:28 800. The maps depict in detail all cities and small settlements, arable land, forests and meadows. Maps are undoubtedly an important source of information for land use, because they reflect the state of the landscape before the onset of the so-called industrial revolution, after which the landscape underwent many irreversible changes (Škabrada 2005, Kuna 2004, 389).

Another valuable source for land use study are the Indicative sketches to the Stable cadaster, the basis after which the Stable cadaster maps were printed. The advantage of this cartographic source is that it contains sketches of changes in buildings and field parcels in the second half of the 19th century. An important advantage of the sketches is that build-up areas of settlements were depicted on separate sheets in doubled magnification.

Additional sources of cartographic information for the purpose of our research include old military maps of the Czech Lands, which cover the period from the 1840s to the year 1880. The most important of these for my topic are topographic maps of Second and Third Military Mappings. Second Military Mapping is dated between 1842 and 1852. The maps were executed in the scale of 1:28 800 and they used the geodetically correct Stable cadaster maps as their spatial reference. Terrain variation was still indicated by the traditional hatching method. Third Military Mapping was carried out in 1874-1880. These maps were drawn in the slightly different (metric) scale of 1:25 000 and used the modern method of terrain description by contour lines, for the first time in our territory (Kuna 2004, 389).

3.3. Pottery collection. The research on the relationships between surface finds and land use in this thesis was based on the already existing assemblage of pottery sherds and few other categories of rare finds (fragments of pipes, horseshoes etc.). As noted, this collection resulted from the surface survey conducted in 2003-2004 in the surroundings of Vladař hill, Karlovy Vary district. The methodology of processing of these finds began with the visual examination of individual pottery finds. The finds were stored in find bags, separately for individual survey lines within 50 x 50 m squares, which represented sectors of survey polygons.

3.3.1. Table of finds and coordinates. Further processing consisted of cataloguing finds. Spreadsheet program Microsoft Office Excel was consistent with our needs and requirements. The main advantage of this program lies in the possibility of direct import of its data into ArcGIS software.

The preliminary analysis of sherds from several survey sectors exposed the need to divide all 4940 collected finds into several specific categories. We used pottery classes as the basis for this description, with the expectation that it should help to understand if there are any regularities in the spatial distribution of different technological groups of sherds. Likewise, it should help to figure out if any chronologically sensitive pottery types disclose patterns of distribution different from other types and what spatial extent is characteristic for each pottery group. This problem stems from the main working hypothesis of this bachelor thesis.

The resulting pottery database provides information on summed pottery finds per individual sectors of 50 x 50 m and contains 12 descriptors for these square sectors, which were used as basic spatial unit for GIS analysis. Among these variables are notes about the localization of finds, such as the name of polygon and the number of square, GPS coordinates of the middle point of the sector. Furthermore, the table includes the total number of finds for each square and the division of finds into technological groups or categories of ceramics.

Such division is necessary not only for the purpose of dating ceramic material. Research on spatial patterns allows gaining a deeper understanding of the spatial distribution of pottery that can help to interpret formation and post-depositional processes and ways of handling ceramic refuse (Čapek – Militký 2016, 121).

Typological analysis revealed the need to divide the pottery finds into 10 groups according to their technological characteristics, which are expected to possibly unravel distinctive patterns of their spatial behavior. These groups include: a) glazed ceramic sherds, b) sherds without glaze, c) sherds covered with brown glaze, d) white glaze, e) porcelain, f) stoneware, g) fragmented stove tiles, j) porcelain and ceramic pipes, k) slag and the last category named l) “individual finds”.

3.3.2. Criteria description. The chosen descriptive attributes represent basic technological qualities of pottery finds. The type of surface finish of ceramics was of primary interest in this classification.

Glazed and unglazed pottery sherds represent large groups of finds. They count 1690 pieces of glazed pottery sherds and 1256 pieces of pottery sherds without glaze, 2946 pieces in total. The category of glazed pottery has been divided into several subcategories. They described more specific characteristics like transparency or opacity and color of the glaze. However, in practice the task was not the easy one. Due to the great variability of sherd sizes it was sometimes difficult to discern the type and identify the color of glaze. Moreover, in several cases it was hard even to indicate the presence or absence of glaze. While processing the pottery collection it became abundantly clear that further subdivisions would be excessive and counterproductive. They would not give any meaningful results without the appropriate processing of the collection by a pottery specialist familiar with material of the period in question. This could not be done in the scope of this bachelor thesis, yet separating glazed ceramics into some finer subspecies might be useful for more accurate chronological dating.

The category made up of pottery covered with the characteristic brown glaze is an example of this. It interests us to track the patterns of behavior of this brown glazed ceramics. Similar thoughts are behind the allocating a separate category for pottery glazed with white color.

Obviously, some special types of ceramic products constitute other separate categories. To these special types belong porcelain, stoneware and fragments of stove tiles. Special categories were established for porcelain pipes (4 pieces) and ceramic pipes (1 piece), the relative dating of which might be correlated with the end of 19th – beginning of the 20th centuries (Vyšohlíd 2009). In the same way, findings from a large slag accumulation were assigned to a separate category. Nevertheless, without appropriate analyses it is difficult to draw any conclusions about these slag fragments. The last category, named “individual finds” contains non-pottery finds and some unique finds made of porcelain. In the table of finds these finds got an individual(?) values – “horseshoe”, “snaffle ring”, “ceramic marble” (toy), “figurine”, and “spindle whorl”, respectively.

Findings related to agriculture and field management will undoubtedly be of great value and will contribute crucial information to the topic of our investigation. Of course, household items will not help us to conclude directly about the past farming system in the region, but they still may help indirectly. For example, these objects can provide evidence that they were transported to the fields by human activity (manuring), but for their scattering across arable land several factors may be responsible: ploughing and various natural factors.

3.4. Maps and layers in ArcGIS. The manual laboratory processing of pottery collection was followed by data analysis in ArcGIS software (ESRI: Environmental Systems Research Institute, Redlands, California). This desktop computer program provides efficient tools for handling and processing all types of geographic data. The software allows creating raster and vector map layers and their editing, analyzing, visualization and management. We used the ArcGIS software to analyze pottery distribution patterns in the vicinity of the Vladař hill. These pottery distribution maps were compared with various types of background maps, including standard topographic maps, orthophotomaps, historic maps or terrain relief models based on aerial laser scanning (5G).

The Stable cadaster. Essential sources for this work were maps of Stable cadaster and their Indication sketches (a colored handmade map supplement to the Stable Cadaster). Without this source, our analysis of past land use types could not be properly conducted. For our study were used cadastral maps of five cadastral districts.

These maps help to determine the boundaries of the fields in the pre-industrial era. The Indicate sketches are then an indispensable source of information about the owners of the fields and references to concrete estates. This information can help to find characteristic land use management of whole communities, as well as the differences between types of management on private and public land.

Kontaminace.cz. One of the external sources for the study of the area of interest was the online resource kontaminace.cenia.cz. This dynamic map provides access to vertical aerial photographs of the entire Czech Republic. The content of the site is presented by VGHMÚ Dobruška and it has arisen as part of the project "Narodní inventarizace kontaminovaných míst" (NIKM). Aerial photographs for the region of interest reflect its state in the year 1952. These images are particularly interesting for us to compare the status and type of use of agricultural fields during the process of collectivization.

All the above-mentioned sources give the opportunity to trace the changes that have occurred in the landscape around the Vladař hill in the course of over 150 years in the recent past and to compare the state of this landscape and the field systems in that region at different times of their existence.

4. Results and discussion

The purpose of this work was to identify a possible relationship between the spread of pottery sherds in the modern fields and land use regimes in the past. The next goal was to identify other patterns with information potential in the behavior of the ceramic finds in the ploughsoil. The data obtained during the processing of the pottery collection from the vicinity of the Vladař hill indicate a number of patterns in distribution of ceramics. The data obtained by the analysis of archival cartographic sources and the results of aerial photographic survey revealed many links and regularities between the distribution of ceramics from the second half of the 19th and early 20th centuries and the land use during this period. Present-day satellite and aerial imagery help to monitor the status of these fields today.

4.1. Pottery sherds patterns. After processing the surface collection, the resulting database was visualized as a grid of symbols, whose size indicated the number of finds in individual squares (sectors). We can find several clusters of finds in the fieldwalked polygons (Fig. 1). The highest density of finds was identified near the settlements in the polygons Vladořice A, B, C, Močidlec B and Stvolny A. Polygons Močidlec A and Pšov A do not show intensive pottery accumulation. As a separate problem, I would like to mention Žlutice A and Žlutice B polygons, on which finds of any type have been completely missing. That observation will be discussed below.

During analysis of patterns created by different groups of pottery classes distribution maps for each class were considered separately and in the comparison with other categories. Such analysis helps to specify the patterns common to all pottery groups, regardless its class, or distinguish some traits typical only for specific groups. For example, we can see similar patterns of the spread of general glazed ceramics and ceramics with brown glaze from the middle of the 19th century (Fig. 2). This approach can also demonstrate characteristics (or patterns) typical for individual pottery classes. As an example, we can discuss a comparison of the distribution of general glazed and unglazed ceramics (Fig. 3). As can be seen in Figure 3, unglazed pottery shows more compact patterns with no signs of wide diffusion into the landscape. An analysis of the other types of ceramics did not produce results that differed from general trends (Fig. 4, 5, 6).

However, three large clusters of finds in the polygons Vladořice A, B, C, Močidlec B and Stvolny A are equally composed of all types of ceramic groups. In the next section, we will consider patterns identified at each polygon separately.

4.2. Relationship between finds and modern landscape. All polygons belonging to the same cadaster were considered together in my analysis. This approach allows us to discuss all available information about the development of plough zone managed by individual communities.

Vladořice A, B and C. The most expressive pattern of the distribution of ceramic sherds is visible in the Vladořice A, B, C polygons (Fig. 7). The map shows that in the immediate vicinity of the settlement, the density of the appearance of ceramic finds contrasts with their density in remote areas. The density of finds of all types near the settlement is much higher. It seems that artifacts are to some extend moved across the fields by water, wind and incidental human activity such as ploughing, which leads to their presence in the off-site sphere and creation of "halos" around the settlement. This model has been confirmed for abandoned settlements, where unintentional transport of artifacts is possible due to ploughing of the site (Bintliff – Snodgrass 1988, 508).

It is a noteworthy observation that the density of finds distribution often respects the boundaries of fields from the 19th century, as recorded in the Stable Cadaster (Fig. 8). This behavior is not common for such called off-site, low-density ceramics, which stretches across the landscape and often "ignoring natural barriers to movement" (Bintliff – Snodgrass 1988, 508). So this observed pattern should be considered as an important feature of artifacts' behavior in our case study.

Comparing the location of the pattern of fields obtained using aerial laser scanning, and the system of fields reflected on the maps of the Stable Cadaster (Fig. 9), we have concluded, that a majority of fields in the study area were formerly owned by owners with the last name Praeger. The exeption are several fields in the western part of the cadaster and some meadows owned or rented by residents from Kolešov. Upon further consideration, it becomes obvious that the fields nevertheless belong to different owners, who were probably relatives. On the indicating sketch to the stable Cadaster we meet names Praeger Johan, Praeger Anton and Praeger Michael. All fields are divided between parcels number 1, 3, 6 and 8. Each owner held more than one field. The spatial distribution of their fields varies. Each family owned fields that were situated close to the settlement as well as in other locations, including the marginal areas of the cadaster.

With all this said, we can see an apparent difference in the distribution of pottery finds in the modern fields. It constitutes a radiating semicircle pattern with a center located in the settlement of Vladořice. The conclusion that can be drawn from this is that the area near the settlement was manured in the past more intensively than the area farther from the settlement (Wilkinson 1989). It is clear from the fact that pottery in the fields fell on them mainly with manure for soil fertilization. It is a simple logical way for archaeologists to determine whether a particular field has been fertilized in the past was findings of pottery sherds, which were used in the homesteads or farms (Jones 2004, 162).

The explanation of this pattern is possible in two logical ways. The first is that the fields located at a close distance from the settlement were fertilized more often than the fields distant from it. The second is that the fields in the immediate vicinity of the settlement were fertilized longer (in time) than the distant fields. This could be associated with a natural increase of the area of arable land and could identify the direction of its expansion. However, such option might be tested only through comparison of ceramics distributions from the older medieval to industrial periods. Considering the fact that our research was conducted mostly on the basis of a collection of modern ceramics from the 19th – early 20th centuries, we tend to prefer the first hypothesis. Thus, it is possible to assume that the fields situated closer to the settlement of Vladořice were fertilized more often, perhaps simply because of the convenience of the location.

Močidlec A, B. In the polygons Močidlec A and Močidlec B we can observe two different, contrasting situations in the behavior of pottery finds (Fig. 10). At the polygon A, there is a significantly large accumulation of pottery sherds in the central part, dissecting the entire polygon diagonally from northwest to southeast. Whereas at the Močidlec B we do not observe any strong accumulations of ceramic material. The explanation of the identified differences will be given separately for each polygon.

Močidlec A. In the case of the Močidlec A polygon, we observe a distinct accumulation of ceramic finds that diagonally runs across the entire polygon from northwest to southeast. Based on the data from aerial laser scanning (Fig. 11) and topographic data (Fig. 12), we can conclude that we see evidence here for rill and sheet erosion. Water erosion, in its various forms, is the most prevalent degradation factor of soil in the Czech Republic as well as worldwide (Šarapatka - Bednář 2015). Therefore it is not surprising to conclude that specific appearance of surface findings may be related to increased erosion of the area and the accumulation due movement of findings along the slope (Smrž – Kuna – Káčerik 2011, 180). Other possible factor influencing the deposition of a large amount of ceramic material in this distinct pattern is attributable to transport of ceramic fragments from the upper layers of the slope towards its bottom during the modern ploughing (Beneš 1998, 188).

During slope erosion, the soil is carried away in the direction of the deepest point of the slope, which is accompanied by the deposition of material. As a result, erosion rills filled with ceramic debris and other artifacts due to the downslope transport by both nature and man (Gojda 2000, 98; Gojda - Trefný 2011, 97; Bintliff – Snodgrass 1988, 508).

Thus, the accumulation of ceramic fragments at the Močidlec A polygon apparently arose in the process of soil erosion caused by modern intensive, arable agriculture in an undulating region. The observed pattern of pottery distribution in this extensive field corresponds largely to the ongoing transformation processes of the archaeological record. Recent dynamics of surface terrain morphology thus obviously contributes to formation of distribution patterns of pottery fragments dating even to the last two centuries. It becomes clear that the soil erosion processes have been quite intensive in the period after collectivization of agricultural production, and our results are in good agreement to similar observations from the Hutná fluvial plain in North-West Bohemia (Smrž et al. 2011, Fig. 7A).

Močidlec B. Polygon Močidlec B did not show any clear patterns suggesting any concrete conclusions. In the southeastern part of the surveyed field, which is located closest to the settlement of Močidlec, we can notice a small accumulation of ceramic finds, which, however, does not seem as a convincing cluster. Further survey in areas located closer to the settlement of Močidlec, it would be possible to assess the situation around the village with higher accuracy (Fig. 13).

Stvolny A. The Stvolny A polygon showed characteristics similar to the situation at the Močidlec A. Considering the patterns of pottery distribution, we have noticed pottery behavior trends characteristic for downslope transport process (Fig. 14, 15). The maps prepared in GIS suggest that the observed clusters of pottery sherds evidently surround two small geomorphological elevations.

Žlutice A, B. There are no pottery finds at polygons Žlutice A and B (Fig. 16). Nevertheless, it should be noted that the negative result of the surface survey at these polygons does not necessarily indicate that it was due primarily to deficiencies of the methodology used during the survey. The collections were carried out at all investigated fields with approximately equally experienced groups of fieldwalkers. The collections around Žlutice were carried out during spring works; there were no crops in the fields (field documentation). In the 19th century, according to the Indicate sketches maps of the Stable Cadaster, this site was a part of arable land (Fig. 17). On the 2nd military maps (Fig. 18) and aerial photographs from years 1938 and 1952 (Fig. 19, 20), the fields were used for agricultural production throughout the entire period. Therefore, we cannot assume any special circumstances for the Žlutice polygons, and the data obtained by fieldwalking will be considered as of equivalent quality with those of other polygons.

However, this negative result of survey may also indicate the peculiarities of land use in this area. For example, during research conducted by D. Davidson in Orkney (United Kingdom) he found accumulations of pottery in manure material directly in the area of a farmstead, because surrounding local soils were inherently fertile (Davidson 1986). But in our case, the reference to the Indicating sketch maps for the Stable cadaster can probably refute this type of explanation for Žlutice polygons. In figure 21 we can detect a wasteland (Oede in German original) and public meadows, as same as fields related to the Žlutice hospital (Luditz Gemeinde Spital) between survey polygons Žlutice A and B. The presence of wasteland can be an indirect argument against the assumption of high soil fertility of this area.

It can also be argued that polygons Žlutice A and B are located at a large distance from the center of the cadaster - the town of Žlutice, and most importantly removed from the place of residence of their owners (Fig. 22). According to the indicating sketch of the Stable Cadastre, these parcels of land have been belonged to the owners - Kleiber (parcel No. 192), Honauer (parcel No. 25, 39), Frank (parcel No. 205), Wohlrab (parcel No. 174), Eisenkolb (parcel No.178, 223, 53). And some of the parcels had the status of public land - Luditz Gemeinde Spital, Gemeinde Wiese. For the three of five owners it was possible to identify that they owned other field parcels that were closer to the city, or were more accessible to transport (Fig. 23 a, b, c).

PšovA. The least extensive among studied polygons was Pšov A. The data obtained during the survey in this polygon were scarce (Fig. 24). A slight accumulation of ceramic material was noticed in a narrow strip between the field road and a small patch of forest. Given the lack of data, we cannot indicate any specific features or pottery behavior.

4.3. Additional observations. One of the unexpected results of this research project was the discovery of field systems of the 19th century surprisingly well preserved in the modern woods and forest patches. Good evidence for this can be seen in Figures 25 and 26, where we can clearly see traces of regular linear features.

In a comparative analysis of these features detected in DTM model based on LIDAR data and stable cadaster maps (Fig. 27, 28), it turned out that the elements present in the digital model of relief are preserved field boundaries of the 19th century. In essence, they represent examples of unique preservation of structures important for studying former land use, of which nothing was known before.

Moreover, the collected data provides us with an opportunity to trace the development of the forest pattern in a specific area nearby the Pšov A polygon. Here we can observe the very beginning of the transformation process of arable land into a compact parcel of wood, when its owner named Pohner divided it into two parts and began to grow trees on one of them (Fig. 29).

Therefore, we may conclude that the transition to forest management in this area occurred during the period prior to collectivization in Bohemia. We can draw this conclusion from the evidence in the southwestern part of Pšov A polygon, where the outline of modern forest fully respects and preserves the shape of field parcels No. 19, 6 and 32 from the 19th century (Fig. 30).

Such relationship between archaeological features and present day woodland relates to the field of archaeology called "archaeology of woods" or sometimes "archaeology in woods". "Archaeology in woods represents the evidence of early land use and activities such as settlements, burial mounds and field systems before the present woodland cover became established" (Yarnell 1999, 103).

In case of discovering any archaeological features of this kind in modern forests, the issue of its conservation and future management comes to the fore. Once identified archaeological remains of this type require appropriate protection in current forestry management. Features connected to former land use located in woodland zones are often disturbed by modern management practices and heavy machinery. New discoveries often cannot be immediately incorporated into forest management plans, which would ensure a long-term conservation of archaeological sites. Mistreatment of cultural heritage slows the process of appropriate usage of information covered "under the trees" (Yarnell 1999, 103-106).

4.4. Discussion. In the literature there is an opinion that it is impossible to obtain reliable data by surface collection on archaeological sites with intensive agricultural management (Gojda - Trefný 2011, 92). Another controversial belief of some archaeologists overstates the spatial diffusion of ceramic material during plowing across long distances from the place of their initial deposition. Some research data demonstrate that plowing affects the distribution of ceramics across fields with relatively little impact: "the long-term lateral movement of artifacts beyond a site of their deposition is likely to be rare" (Reynolds 1982, Beneš 1998). In this study, it turned out that erosion processes might have a far greater effect on the final picture of pottery distribution. Therefore, it seems that the most significant factors affecting pottery in the ploughsoil are soil erosion and weathering (Gojda - Trefný 2011; Bintliff - Snodgrass 1988, 512). The weathering is expected to be responsible for destruction of a majority of prehistoric and early mediaeval pottery circulating in the ploughsoil, as the technology of their production usually did not result in durable artifacts. The higher quality, Modern period ceramics, however, can withstand mechanical load and harsh conditions prevalent in the arable layer much longer.

The erosion is nevertheless a very complex process with a complex cause. Erosion can be triggered by natural processes (forces), as well as by inappropriate human economic (agricultural) activities (Beneš 1995; Gojda 2000, 95). Ancient and modern pottery sherds alike can be transported downslope together with soil, especially in large fields that are less resistant to erosion. The resulting distribution patterns revealed by surface survey are biased in such cases (Howland et al. 2018), but they still remain very informative, if correctly interpreted.

There may still be doubts about how reliable the data can be when they are derived from surface survey (Gojda 2011, 98-99). There may also be uncertainties about a chosen method of survey. In collecting finds people with different levels of experience often take part, and it can affect the results from square to square. Some artifacts may remain uncollected because fieldwalkers without experience cannot identify them in ploughsoil, for example. Often the problem is the condition of the field (freshly plowed, sowed) and weather (rain, cold), which can also affect the collection process.

Despite this, we can still conclude that with sufficient attention and interdisciplinary approach, the surface survey data can provide answers to many questions related to land use. The novel conclusion resulting from this study is that surface finds can tell us not only about the land use patterns in Prehistory and Middle Ages, but also for the Modern period, including the last two centuries. Even relatively recent pottery scattered in agricultural fields has valuable information potential, testifying to human behavior in the countryside as well as to landscape processes such as soil erosion and accumulation.

5. Conclusion

The subject of study in this bachelor thesis was the past land use in a small region, which consisted of fields belonging to several cadasters in the vicinity of Vladař hill near Žlutice (Karlovy Vary district). The study was primarily based on the assemblage of artifacts dating from the 19th - early 20th centuries, obtained with the help of surface survey conducted in 2003-2004 on five cadasters - Močidlec, Pšov, Stvolny, Vladořice and Žlutice. We used the methods of landscape archeology and related disciplines to evaluate the data and search for patterns in the distribution of ceramic sherds on modern fields and their relationship to the former land use. Main sources for this analysis were: the collected pottery (4940 pieces), aerial photographs, airborne laser scanning data, and archival documents related to the area and the mentioned period. Among the archival materials, we used published written sources on nearby settlements and tax lists, cadastral and military maps of the 19th century, and vertical aerial photographs the first half of the 20th century.

The fundamental problem investigated in this study was the question of relationships between the distribution of pottery in the present-day arable fields and previous land use. We tested the possibility of identifying their spatial patterns and mutual links. Pottery scattered in the present-day fields is assumed to have gotten there together with manure, brought from settlements in order to fertilize agricultural fields.

In the process of this investigation, we found that in the open arable land between the settlements in the studied region, all classes of collected ceramics (and some other categories of artifacts) form well-pronounced clusters (patterns). Each of these clusters could be explained by different reasons. Some of them obviously arose partly from natural processes, triggered by human activity (soil erosion). This is the case of dense accumulations of pottery in the polygons Stvolny A and Močidlec A. However, in other cases, the distribution of ceramics across the fields was clearly due to processes caused dominantly by the presence of human settlement. One strong example of this phenomenon is the halo of ceramic finds around the settlement of Vladořice. It is highly interesting that in the immediate vicinity of the settlement, the density of the finds was almost twice as high in comparison with remote areas of the same cadaster. We explained this phenomenon by the fact that the fields located closer to the settlement were manured more intensively than the distant fields.

Thus, we can conclude that the relationship between the distribution of pottery in the fields and agricultural management in the past does exist and can be identified using methods of surface collection of artifacts. This conclusion confirms the theory that we put forward at the introductory part of the thesis. It should be stressed though, that for reliable interpretation of spatial patterns detected in the assemblage of ploughsoil pottery, we need supporting evidence in the form of historical maps, written sources, aerial imagery, and LIDAR relief models.

The next research goal of this work was to find out and explain what types of relationships between the distribution of ceramics and previous regimes of land use we can identify using the methods utilized in our approach. The results of the study showed that we can observe different types of dependencies. We can observe a direct relationship between the patterns of artifact scatters and types of previous management of fields. As mentioned above, in the case of the Vladořice A, B and C polygons, the high density of finds indicates an intensive manuring of these fields. Nevertheless, the absence of finds or their small number can also indicate certain regularities in land use. Examples of this observation come from Žlutice A and B polygons and Močidlec B polygon. However, some existing (obvious) dependencies are still difficult to interpret in any way because the data obtained are in some cases ambiguous or the context is insufficient for reliable explanation. An example is the Pšov A polygon, which was represented with only two narrow survey polygons with the accumulation of finds limited only to their northwestern part.

When working with airborne laser scanning data, it turned out that the arable fields, which during the period before the collectivization had changed to forest parcels, preserve the relics of the cultivated landscape of the previous period (field boundaries in our case) much better than any other landscape element of the studied microregion. This circumstance opens up completely new perspectives for us to study land use in Bohemia and the Czech Republic, where the gradual transition from private to collective fields took place after the Second World War.

The results of this research suggest that the discussed methods of analysis of the relationship between Modern period ceramics and former land use can be successfully used in studies aimed at transformations of cultivated landscapes. These methods can help determine the type and intensity of economic (agricultural) activity in a particular area of interest. Reconstruction of a cultivated landscape in whole regions can be achieved by summing up results from reconstructions of individual smaller landscape transects. The development and dynamics of cultivated landscapes is an important part of the general as well as local history, and the non-destructive methodology presented in this thesis successfully contributes to our understanding of landscape transformations in the last two centuries.

Summary

Tato bakalářská práce vychází ze souboru keramiky z 19.-20. století, získané metodou analytických povrchových sběrů v letech 2003-2004 v blízkosti hradiště Vladař. První etapa práce spočívala v dokončení laboratorního zpracování keramického souboru a jeho vyhodnocení. Cílem práce v širším smyslu bylo najít souvislosti mezi prostorovou distribucí keramiky na orných plochách a způsoby hospodářského využití krajiny v minulých dvou stoletích, a se změnami spojenými s moderními metodami zemědělského hospodaření ve vybraném regionu. Samostatně je zvažována možnost existence dalších vztahů mezi prvky využití krajiny (land use) a vhodnými metodami jejich vyhledávání a studia.

Práce je založena na metodách krajinné archeologie, mezi nimiž byla vedle informací z povrchových sběrů využita zejména analýza archivních písemných a kartografických pramenů, analýza archivních leteckých snímků různých období a dat satelitních, jakož i zpracování dat laserového skenování reliéfu.

Vyhodnocení dat v prostředí geografických informačních systémů přineslo rozpoznání určitých zákonitostí mezi chováním keramických zlomků v orné půdě a krajinnými prvky, které vznikly nebo existovaly v 19. až na počátku 20. století. Hlavním výsledkem bylo zjištění, že distribuce keramiky z 19. století na moderních polích dosti věrně odráží známý stav polních systémů v 19. století. Nepochybně by se však měl vždy brát v úvahu vliv erozních procesů, které se vyskytují na scelených velmi rozsáhlých plochách orné půdy (v našem případě na polygonu Močidlec A). V polygonech Vladořice A, B, a C bylo možno sledovat jasný vztah mezi vzdáleností orné půdy od obce a hustotou výskytu keramického materiálu. V blízkosti osady rozptýlená keramika tvoří velmi kompaktní strukturu ve tvaru jakéhosi prstence, hustota nálezů vzrůstá směrem k osadě.

Můžeme tedy konstatovat, že možnost částečné rekonstrukce kultivované krajiny a způsobu novověkého hospodaření na malém území s pomocí analytických povrchových poplatků skutečně existuje. V této práci se nám dále podařilo zjistit, že existují rozdíly v úrovni zachování terénních reliktů v závislosti na typu moderního využívání původní orné půdy. Na otevřených zemědělských plochách podléhají relikty lidských aktivit (v našem případě zejména polní systémy) vodní erozi, zatímco v zóně lesa se zachovávají delší dobu v mnohem lepším stavu. Tato zjištění umožňují formulovat nové hypotézy pro budoucí výzkumy v oblasti krajinné archeologie.

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Appendix

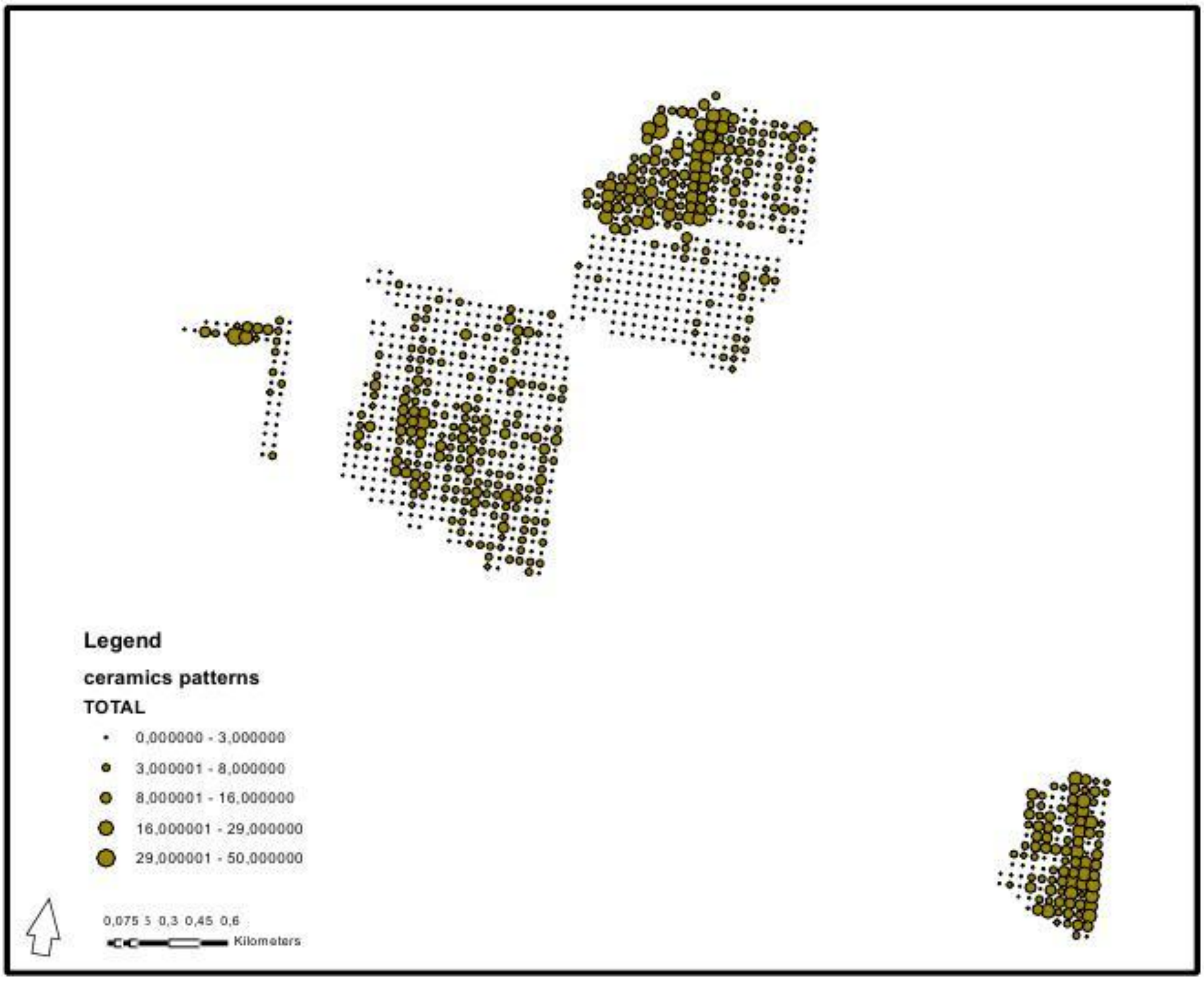


Fig. 1. Results of surface artifacts survey around the Vladař hill (Karlovy Vary district). Clusters of finds can be observed in the studied area.

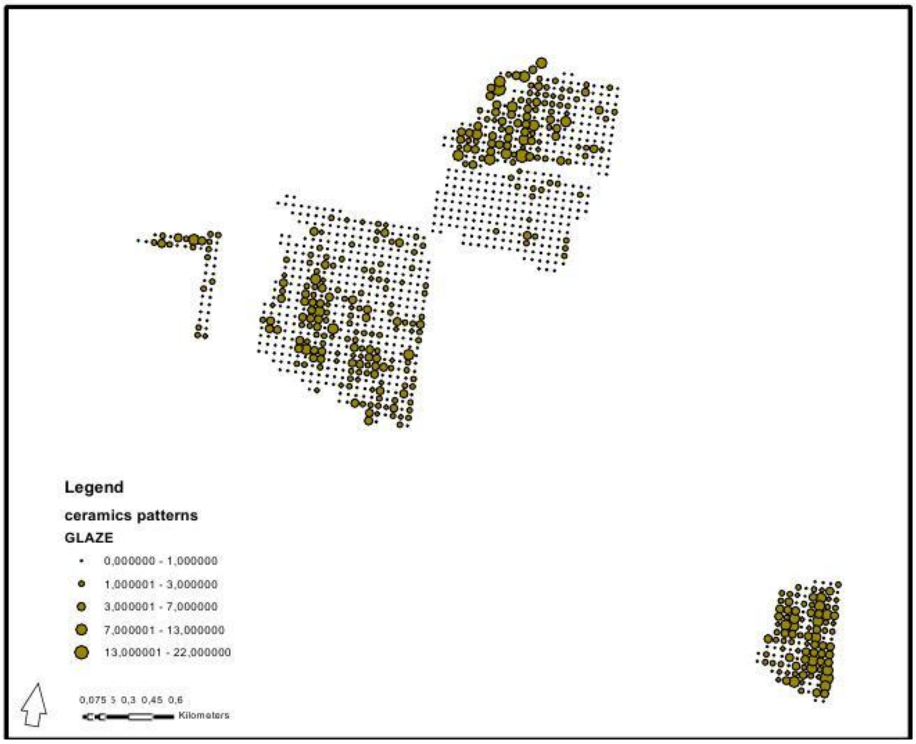
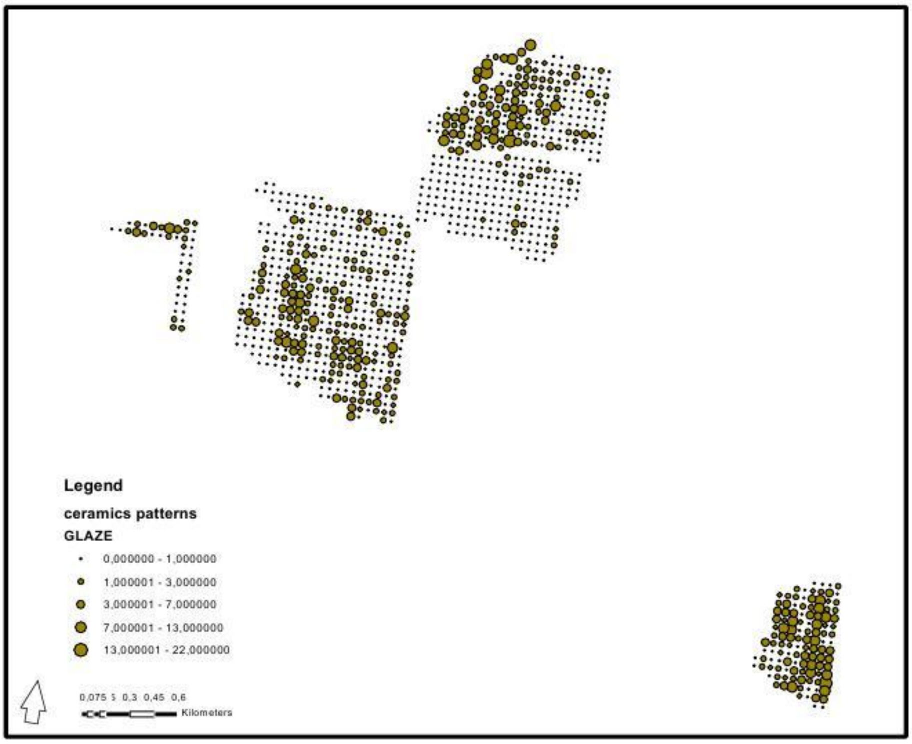


Fig. 2. Similar patterns of spatial behavior of pottery sherds with brown glaze (bottom image) and herds covered with other types of glaze (top image).



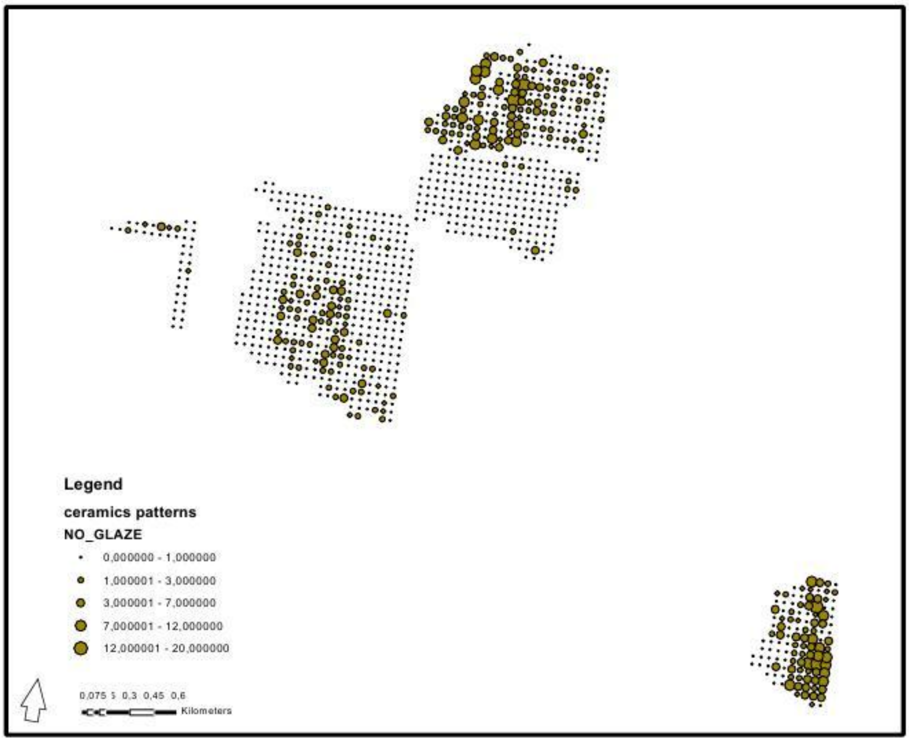


Fig. 3. Comparison of the distribution of glazed (top image) and unglazed (bottom image) pottery sherds. Unglazed ceramics forms more compact clusters with a lower degree of diffusion.

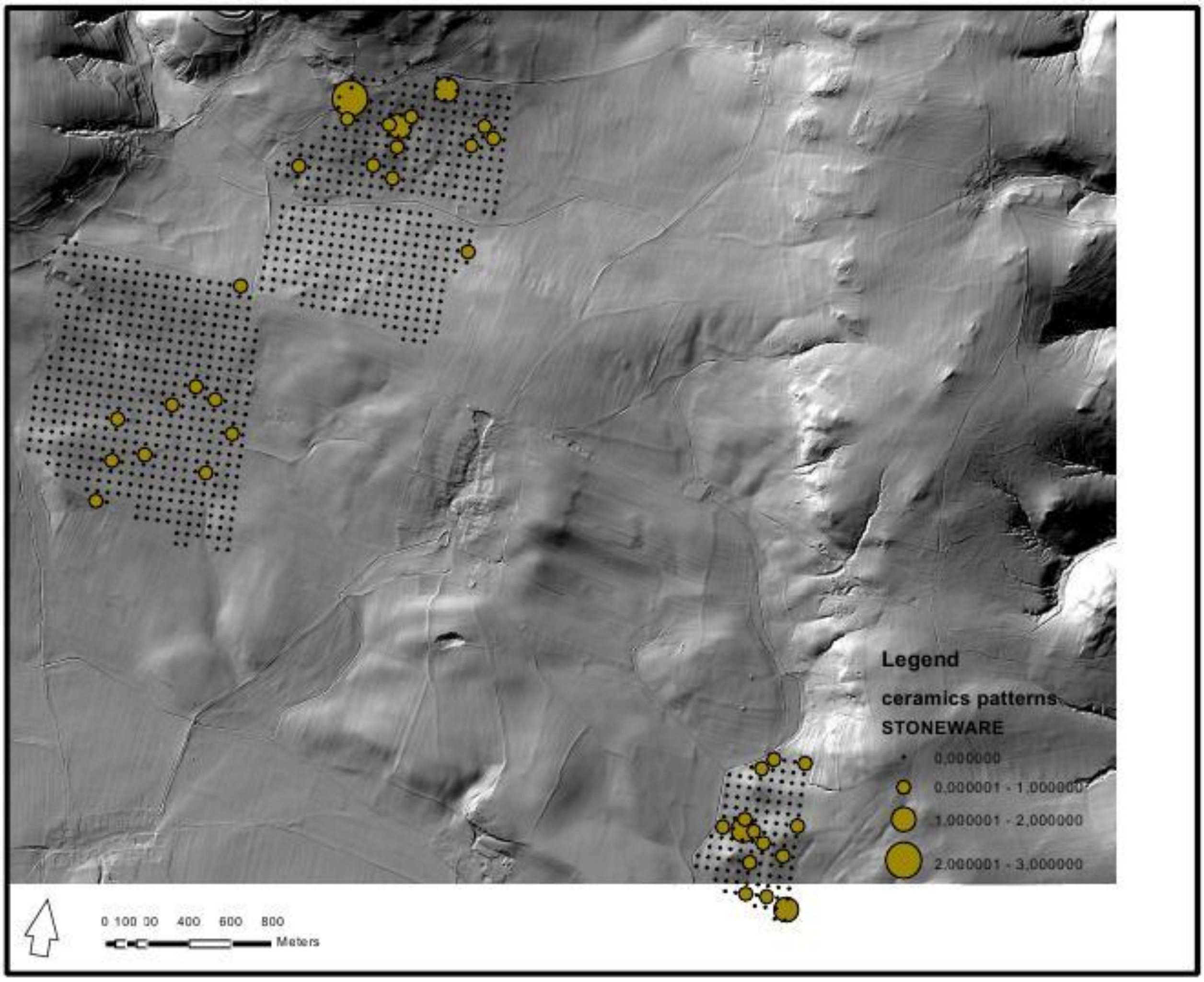


Fig. 4. Distribution of stoneware sherds in the studied area. Map background layer: shaded relief model.

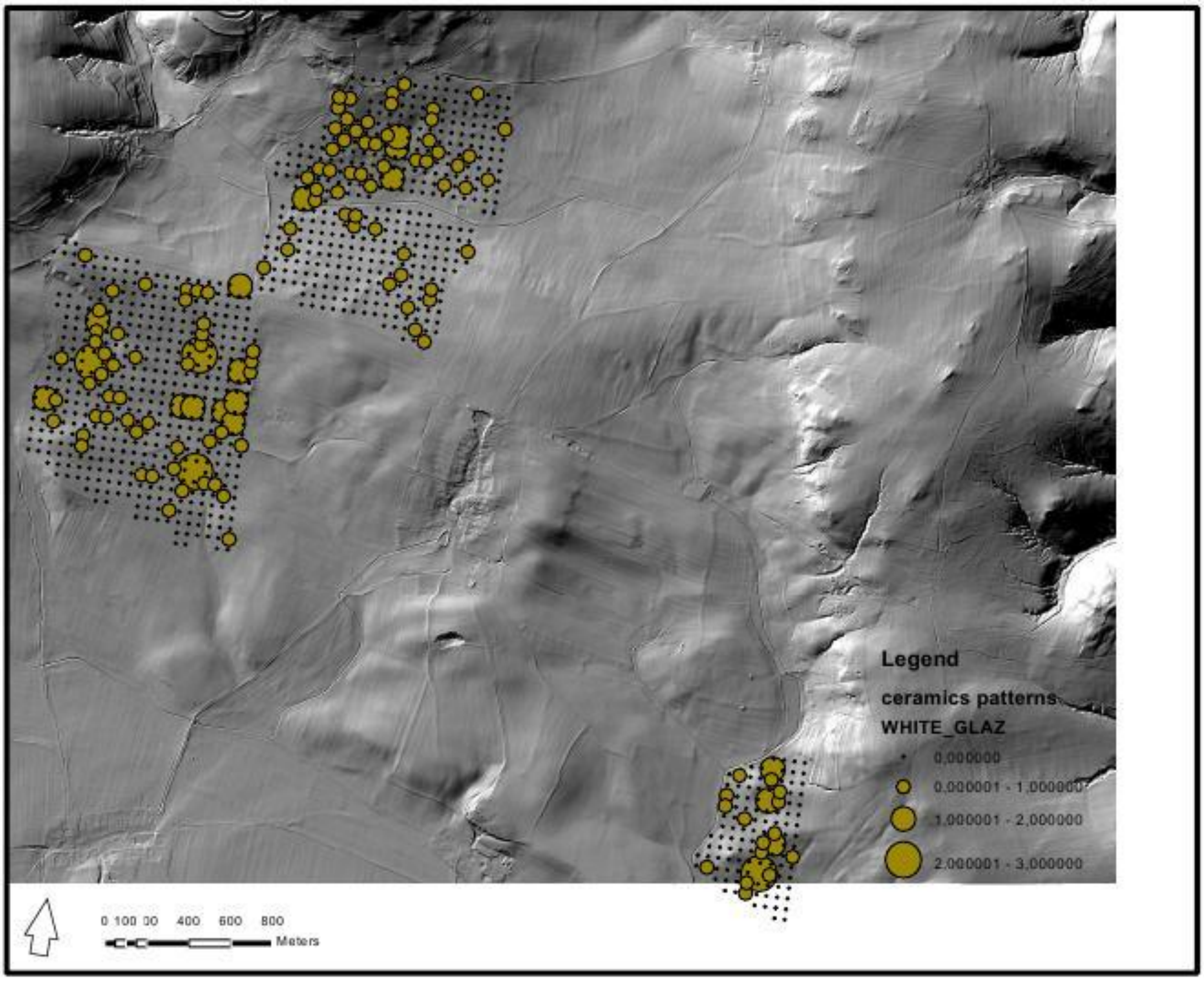


Fig. 5. Distribution of pottery with white glaze. Map background layer: shaded relief model.

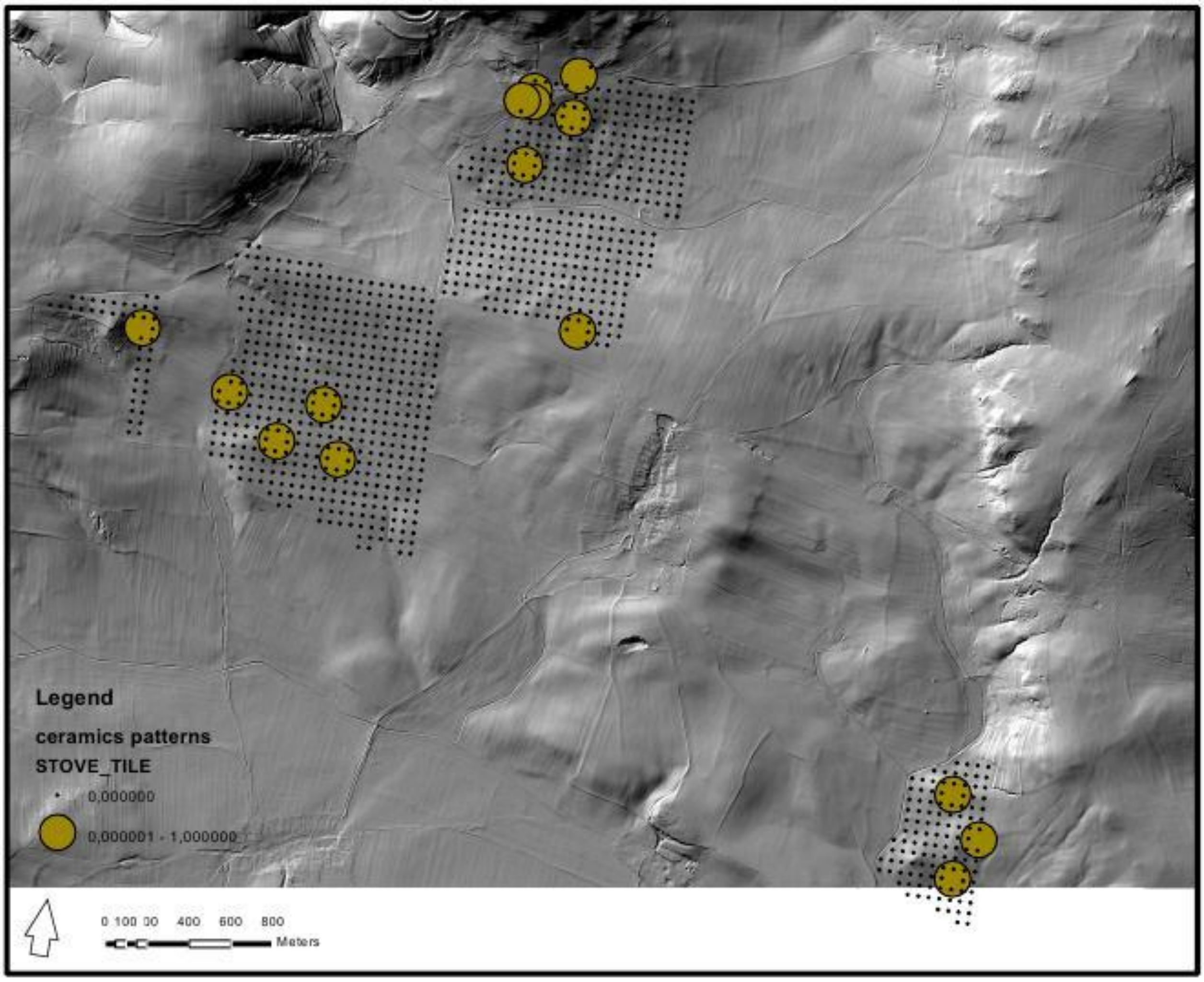


Fig. 6. Distribution of stove tile fragments. Map background layer: shaded relief model.

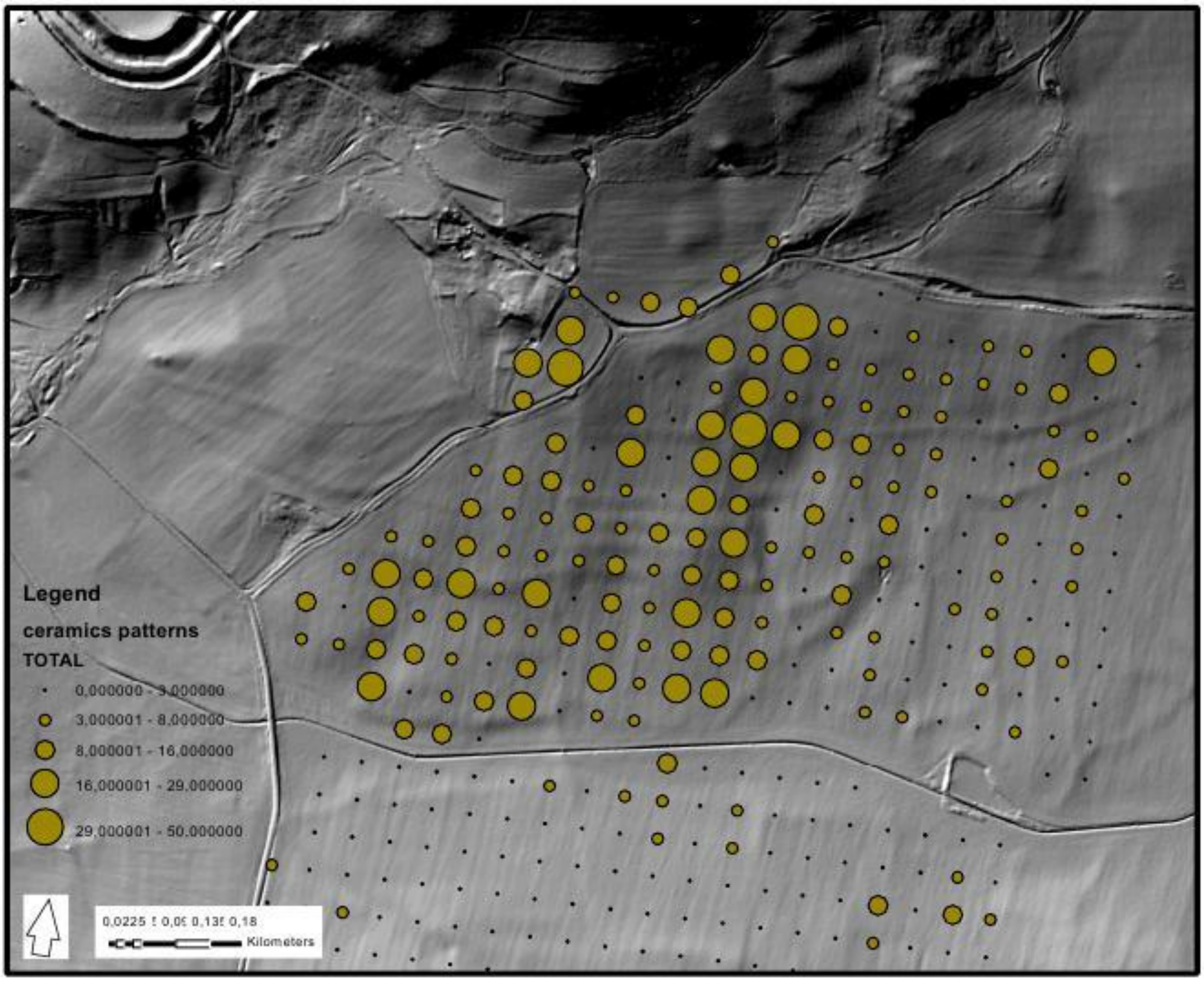


Fig. 7. Large accumulation of ceramic material (of all types) observed in the polygons Vladořice A, B and C. A halo pattern is clearly visible in the area close to the settlement, where the density of ceramic finds contrasts with their loose scattering in remote areas. Map background layer: shaded relief model.

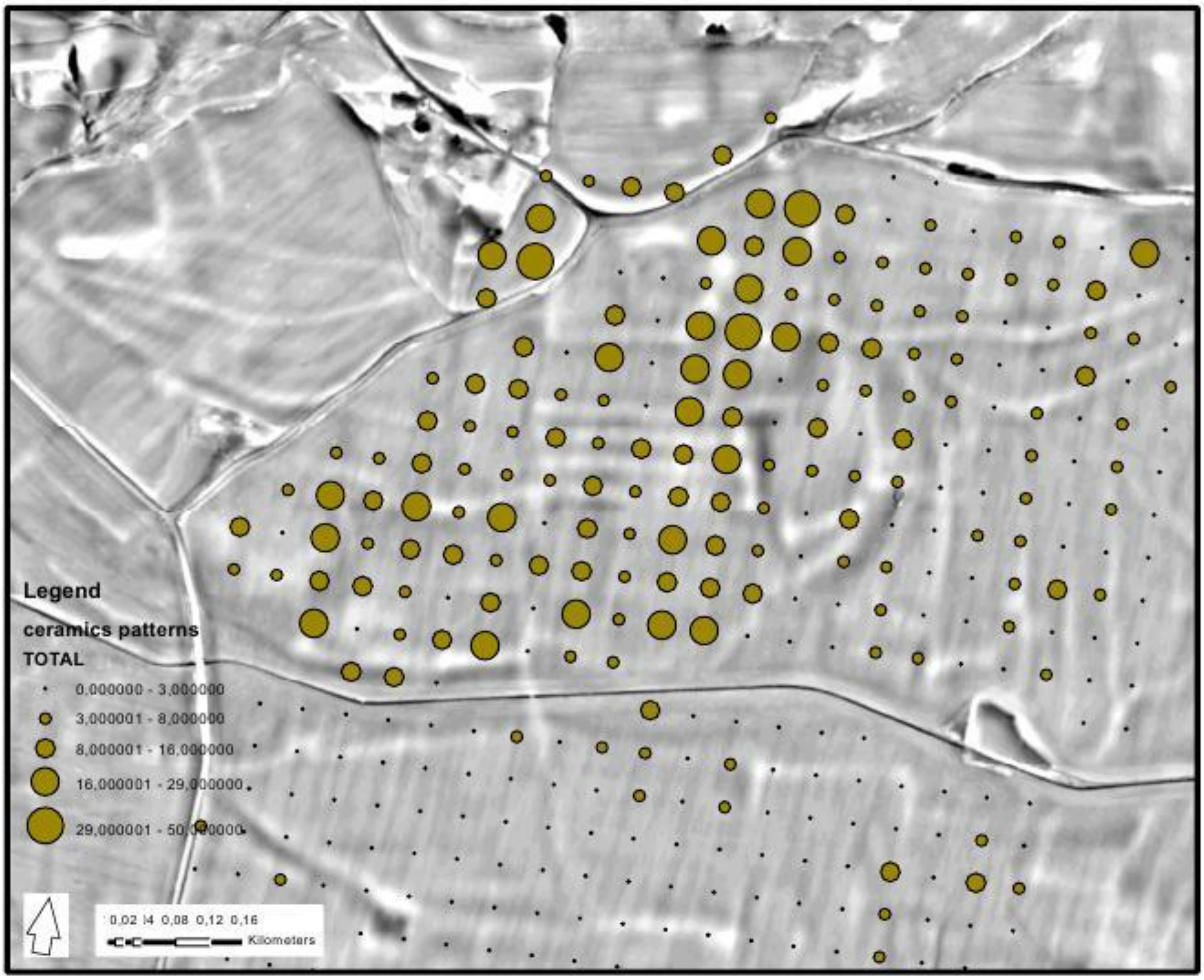


Fig. 8. Accumulations of finds in the polygons Vladořice A, B and C respect the boundaries of field system from the 19th century after the Stable Cadaster. Map background layer: local relief model, low-pass filter.

Fig. 9. Vladořice settlement. An extract from the map of the Indication sketch to the Stable cadaster (1841) showing the system of fields and information about their owners. Image credit: archivnimapy.cuzk.cz.

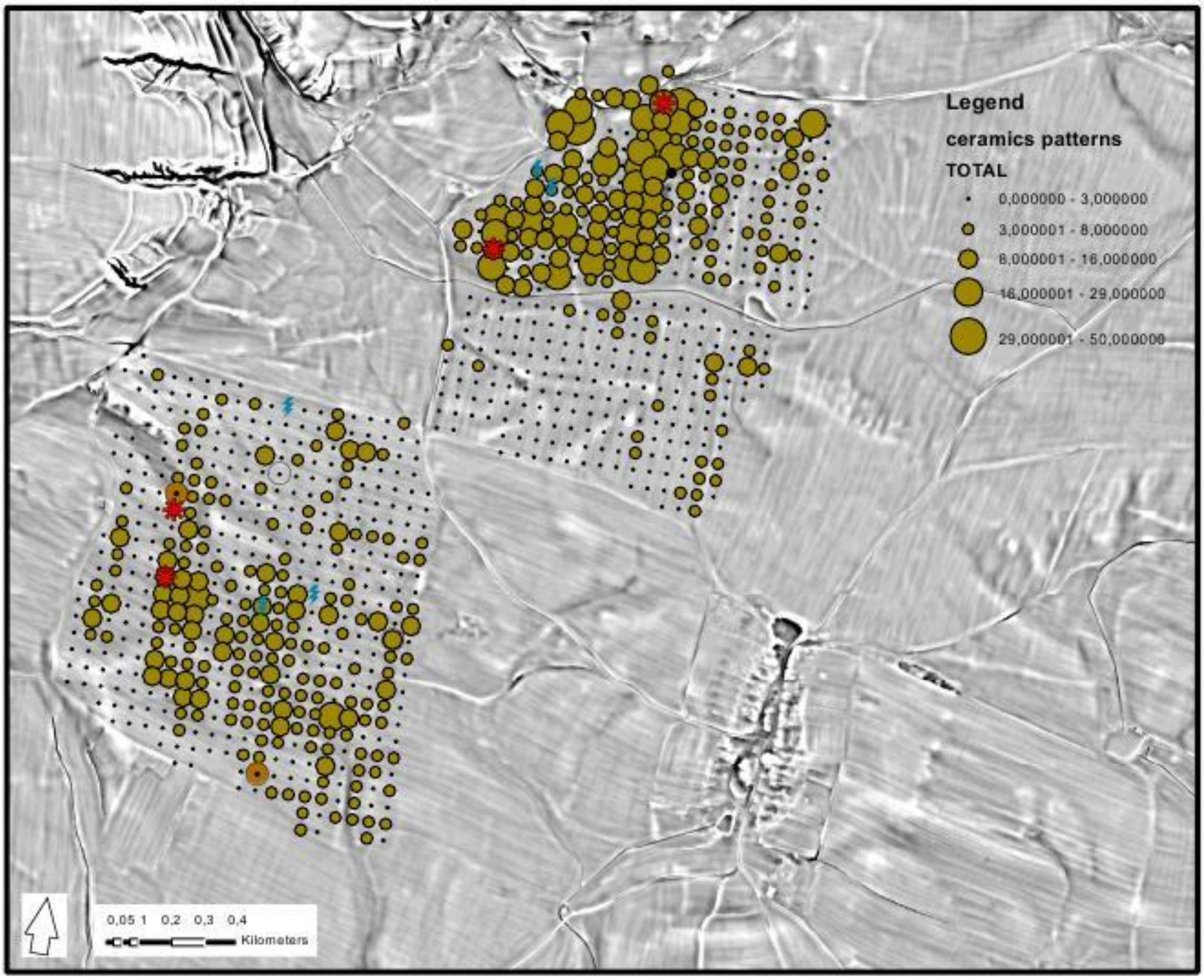


Fig. 10. Polygons Močidlec A and Močidlec B. Močidlec A polygon (bottom arrow) shows a significant accumulation of pottery sherds. Map background layer: local relief model, low-pass filter.

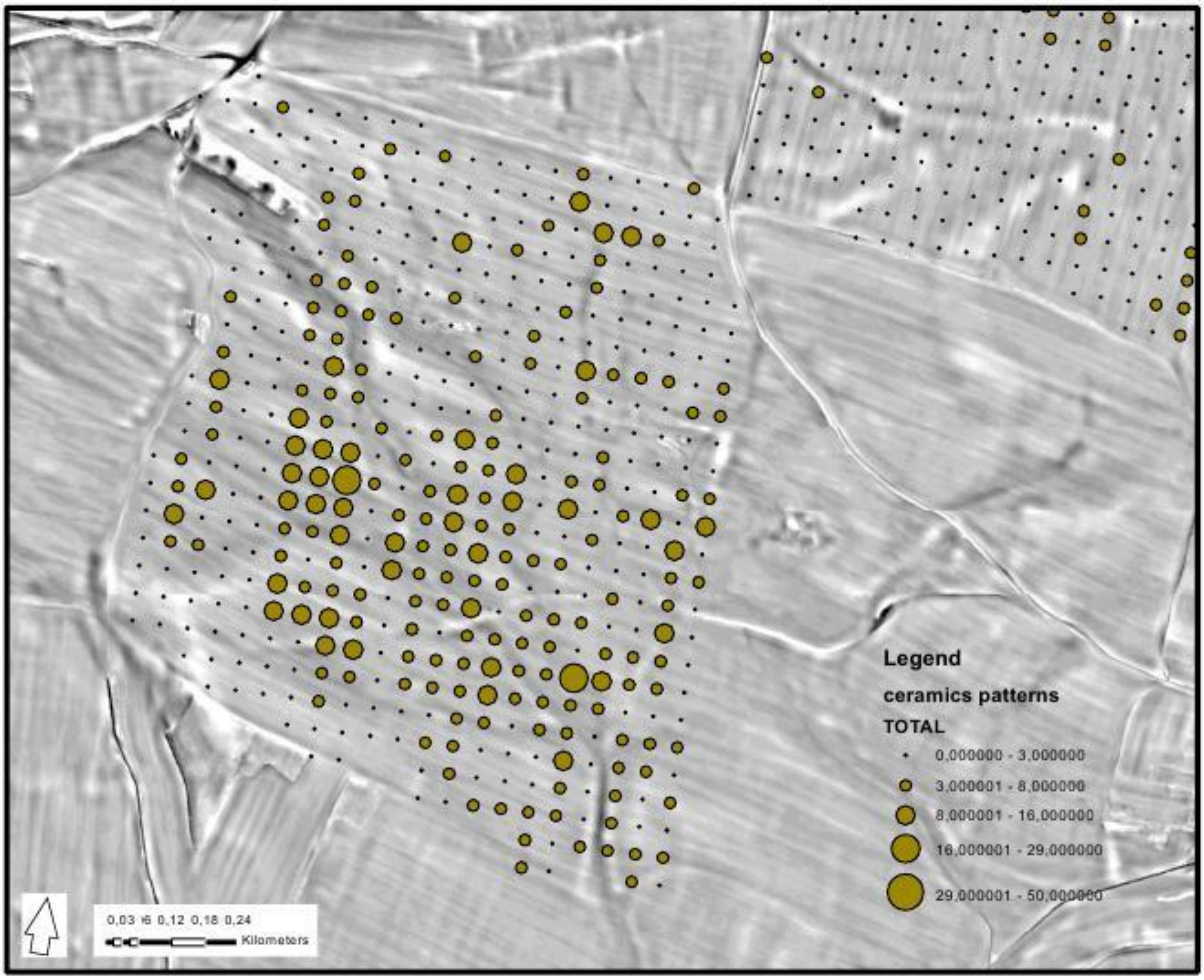


Fig. 11. Patterns of pottery distribution in the Močidlec A polygon. Map background layer: local relief model, low-pass filter.

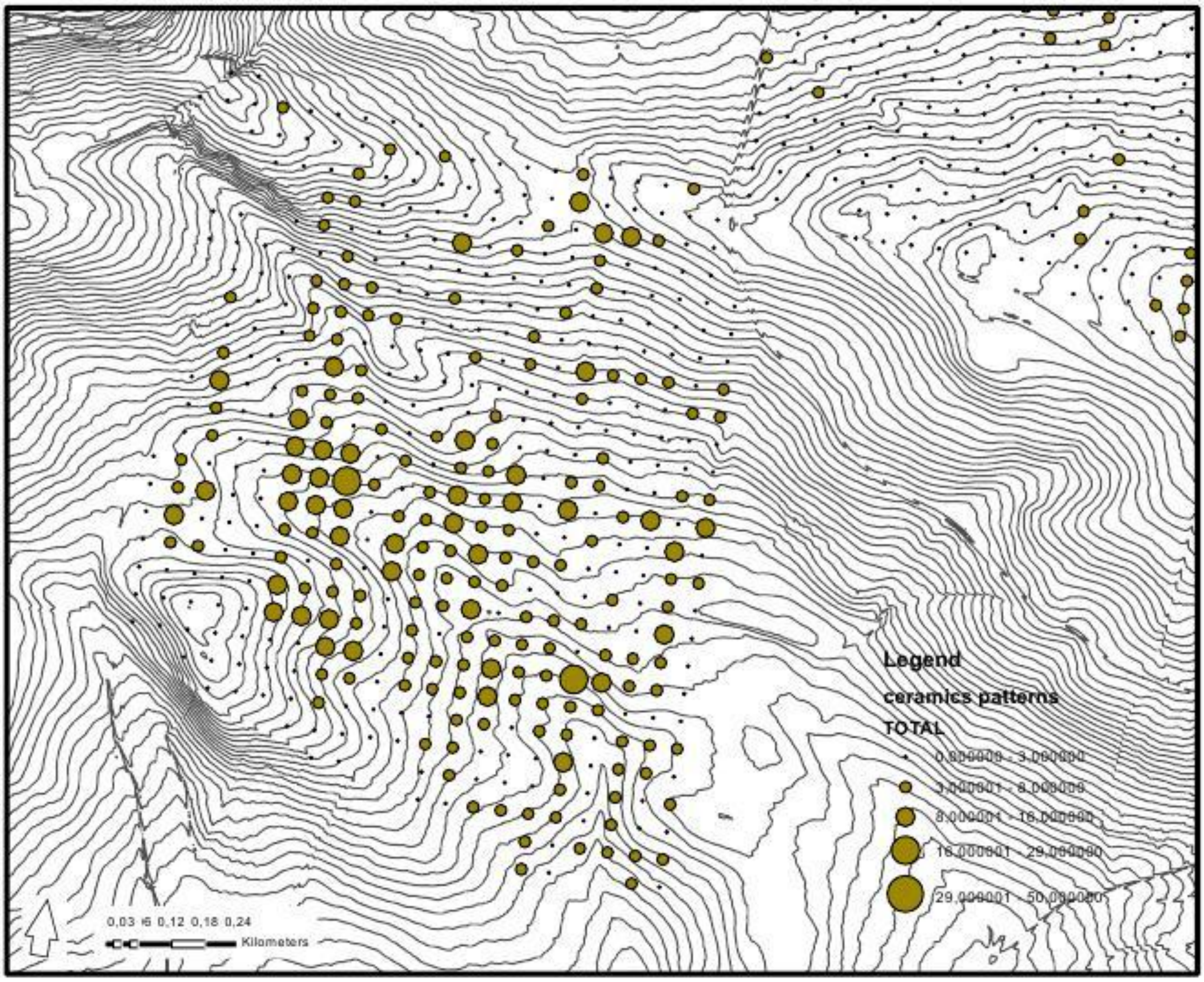


Fig. 12. Patterns of pottery distribution in the Močidlec A polygon. Map background layer: vector contours with 1 m step.

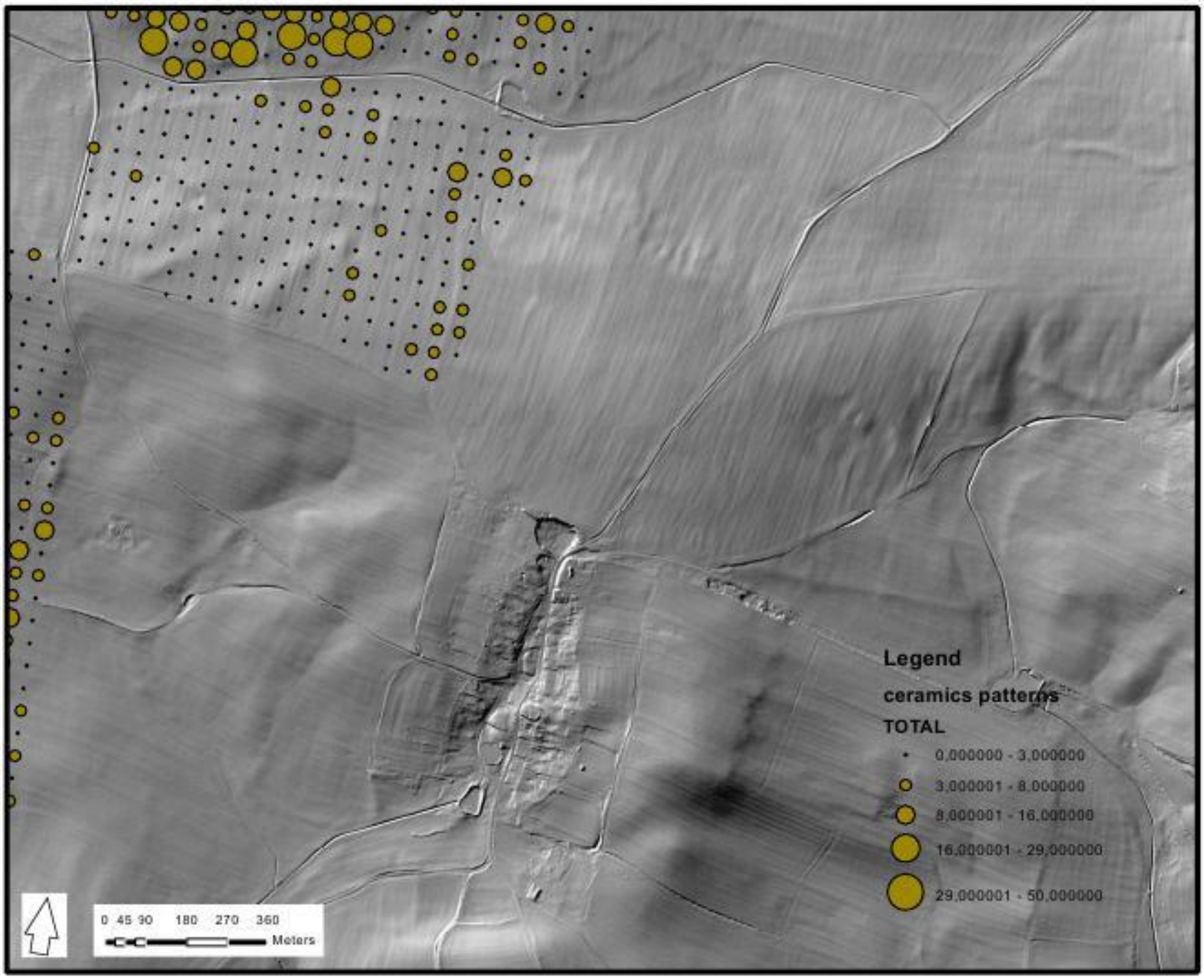


Fig. 13. Močidlec settlement and Močidlec B polygon (top arrow). The image shows a vast area around the settlement, which has not been studied by surface artifact survey. Map background layer: shaded relief model.

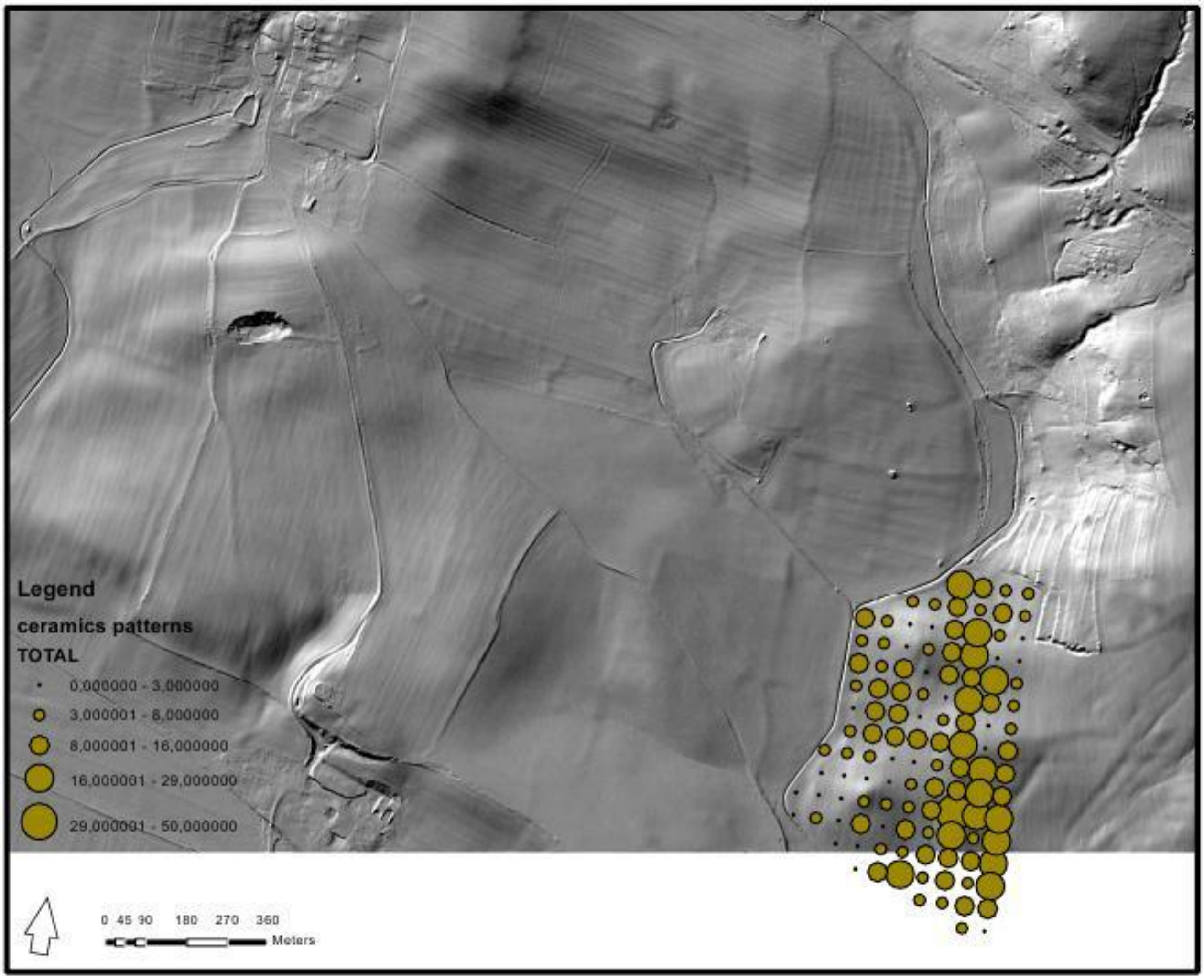


Fig. 14. Patterns of pottery distribution in the Stvolny A polygon, characteristic for downslope transport process by erosion. Map background layer: shaded relief model.

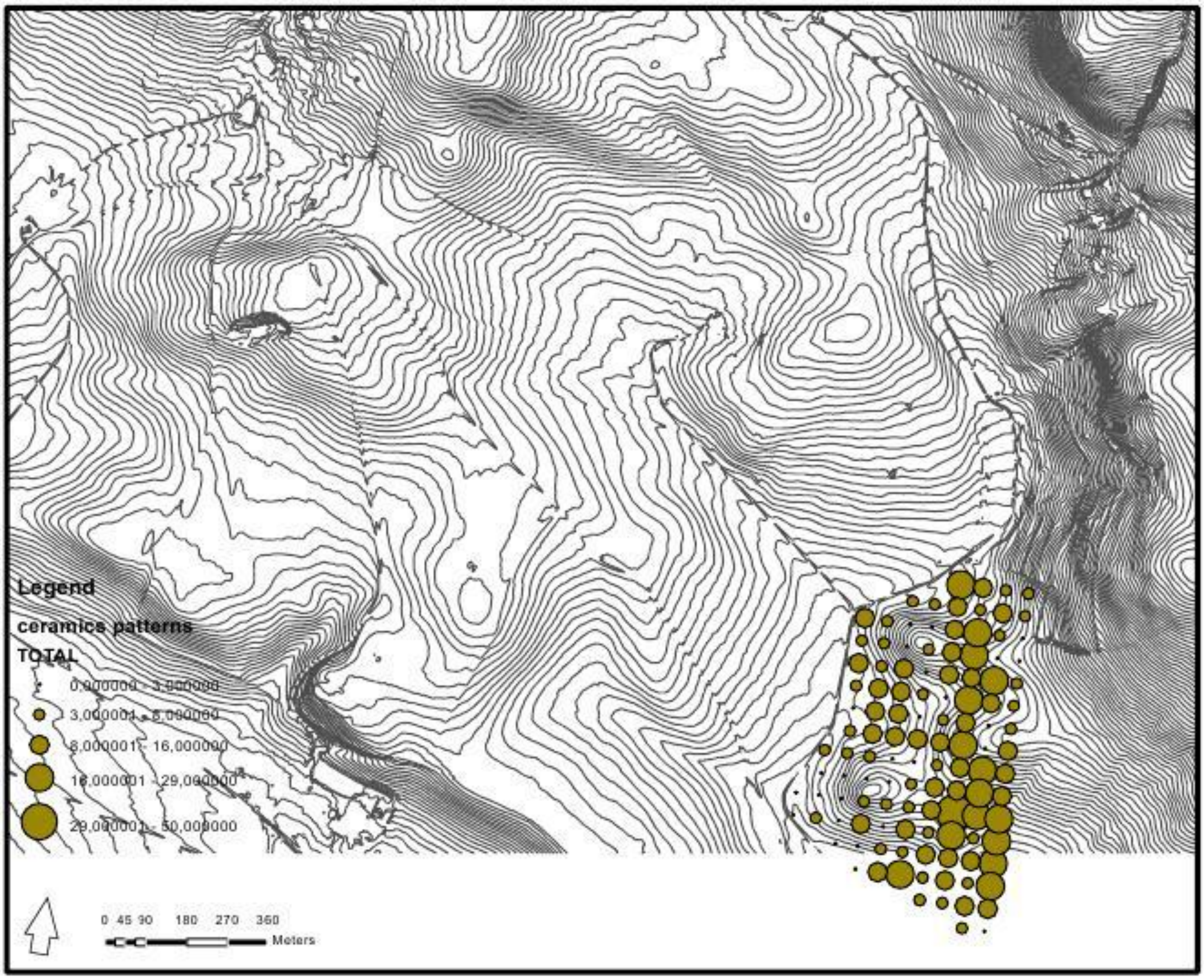


Fig. 15. Patterns of pottery distribution in the Stvolny A polygon characteristic for downslope transport process by erosion. Map background layer: vector contours with 1 m step.

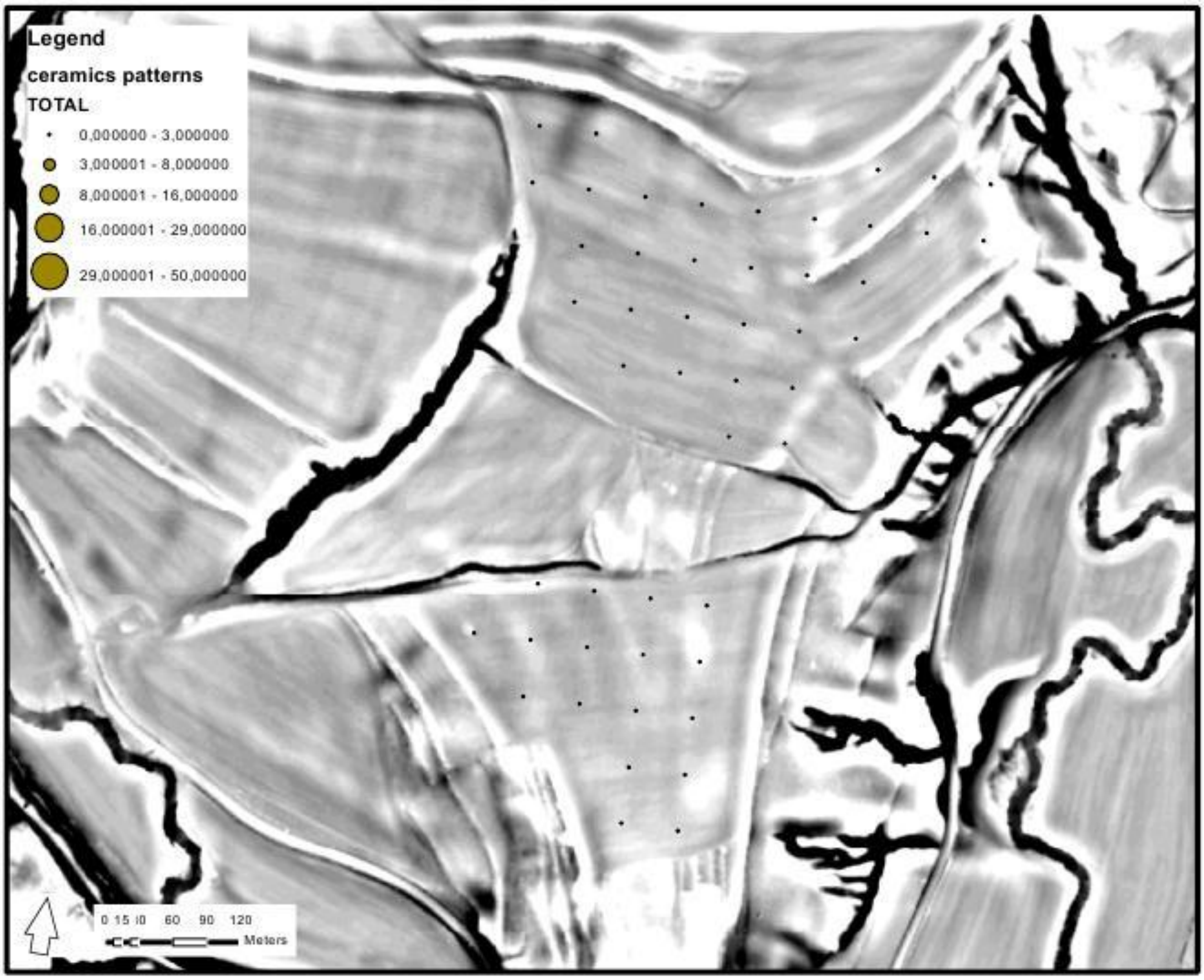


Fig. 16. Polygons Žlutice A (bottom) and B (top), illustrating the lack of finds. Map background layer: local relief model, low-pass filter.

Fig. 17. Polygons Žlutice A and B, according to the Indication sketch map of the Stable Cadaster (1841) this area (Rumpelberg) was a part of arable land in the 19th century. Image credit: archivnimapy.cuzk.cz.

Fig. 18. Polygons Žlutice A (bottom) and B (top), according to the 2nd military maps (1842-1852). Map layer credit: geoportal.cuzk.cz.

Fig. 19. Vertical photograph of the study area from 1938, depicting arable land around Žlutice town, including the Rumpelberg area. Image credit: VGHÚ Dobruška, photo no. 6625.

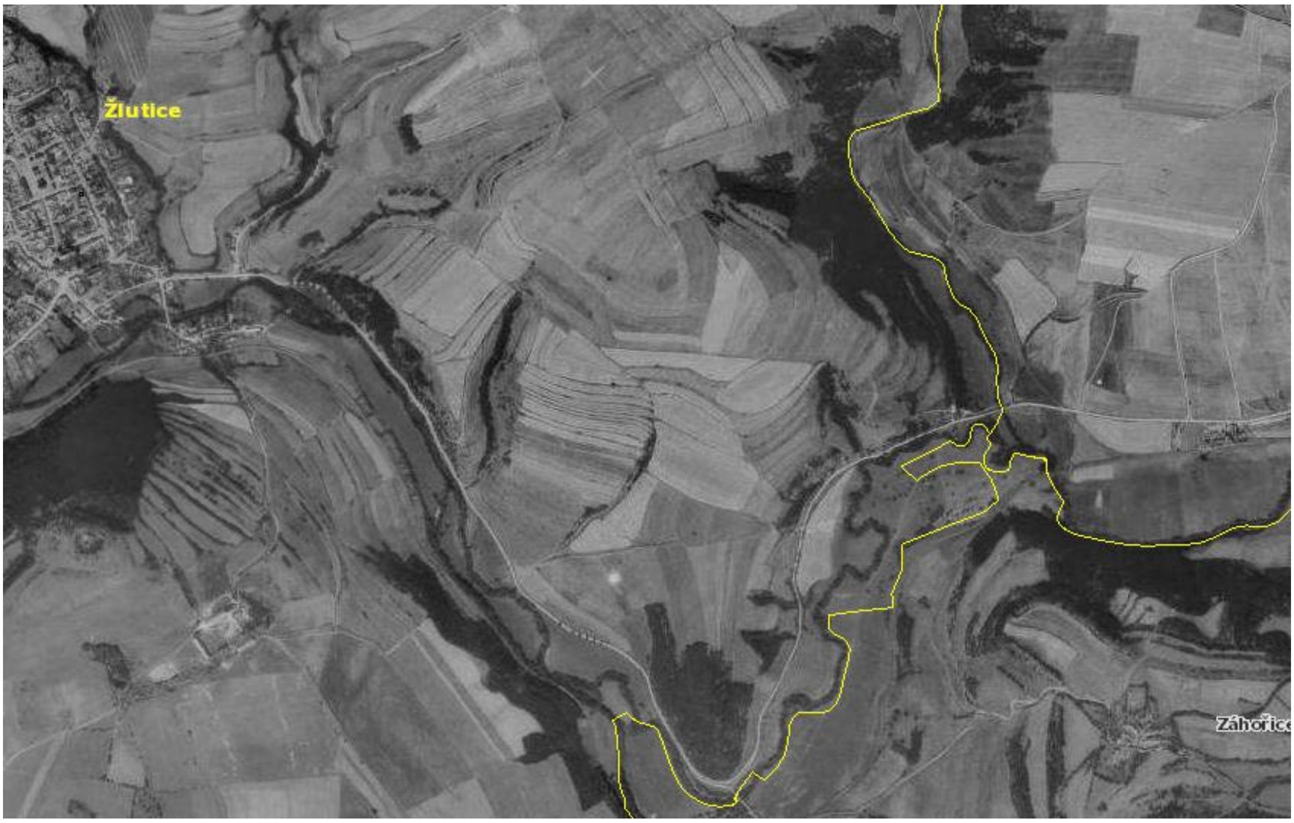


Fig. 20. Vertical photograph of the study area from 1952, depicting arable land between Vladař hill and Žlutice, including polygons Žlutice A and B. Image credit: kontaminace.cenia.cz.

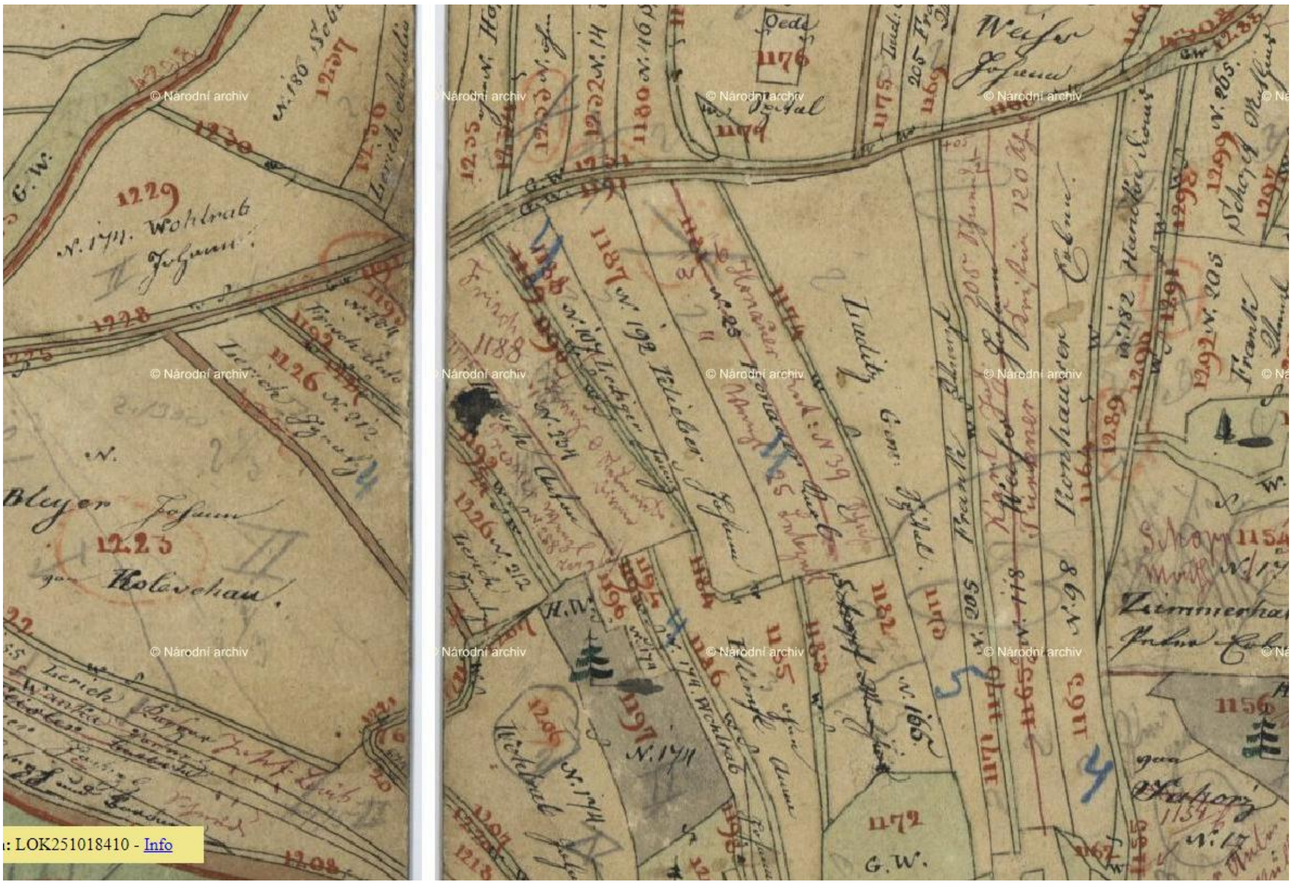


Fig. 21. Extract from the map of the Indication sketch to the Stable Cadaster (1841). Wasteland (Oede in German original), public meadows and fields related to the Žlutice hospital (Luditz Gemeinde Spital) can be observed between survey polygons Žlutice A and B. Image credit: archivnimapy.cuzk.cz.

Fig. 22. Extract from the map of the Indication sketch to the Stable Cadaster (1841). The illustration of the location of polygons Žlutice A and B, situated at a large distance from the center of the town of Žlutice. Image credit: archivnimapy.cuzk.cz.

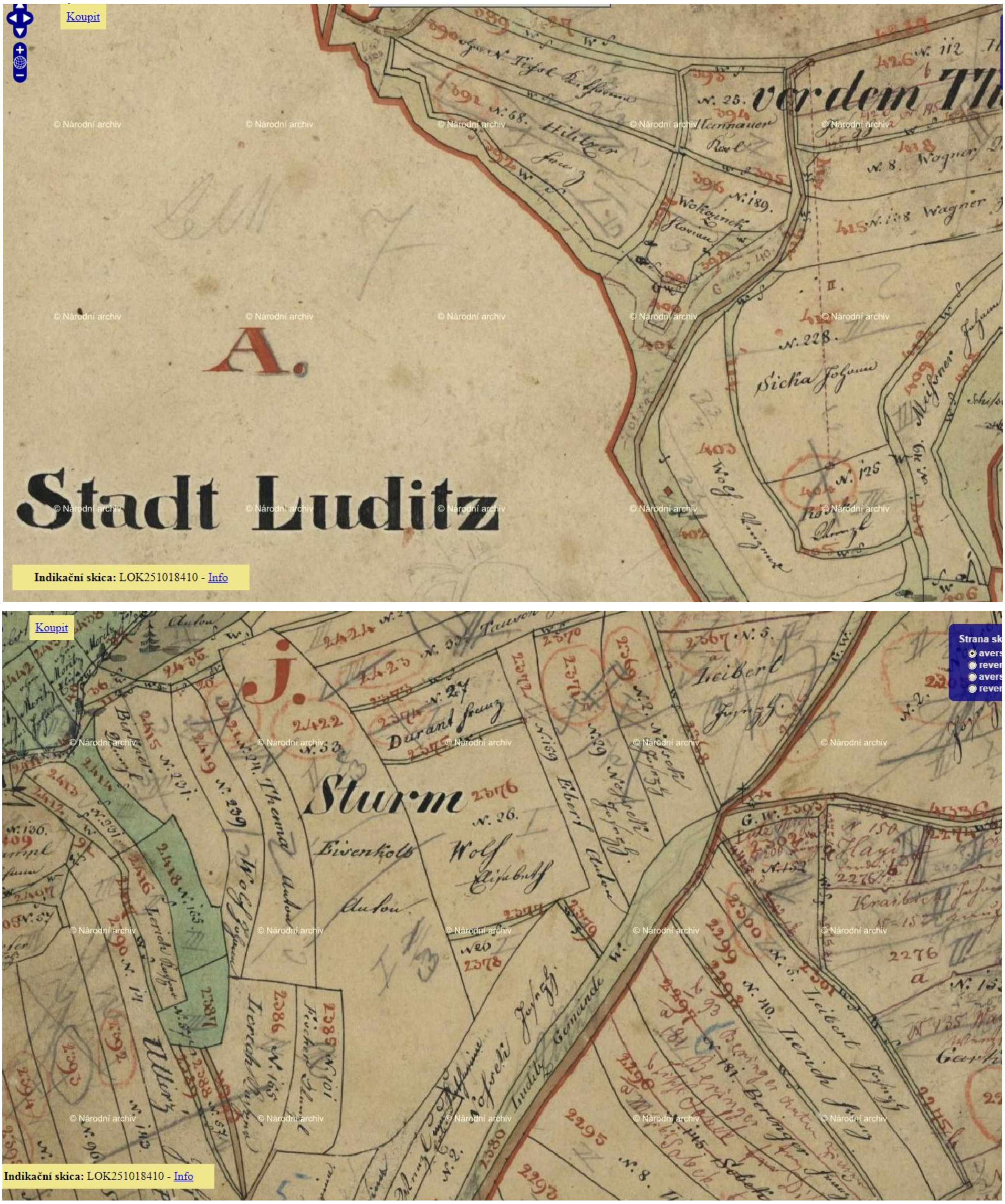


Fig. 23 a, b. Extracts from the map of the Indication sketch to the Stable Cadaster (1841). The illustration of field parcels at Rumpelberg (Žlutice A and B polygons) with the repeating names of the same owners. Image credit: archivnimapy.cuzk.cz.

Fig. 23 c. Extract from the map of the Indication sketch to the Stable Cadaster (1841). The illustration of field parcels at Rumpelberg (Žlutice A and B polygons) with the repeating names of the same owners. Image credit: archivnimapy.cuzk.cz.

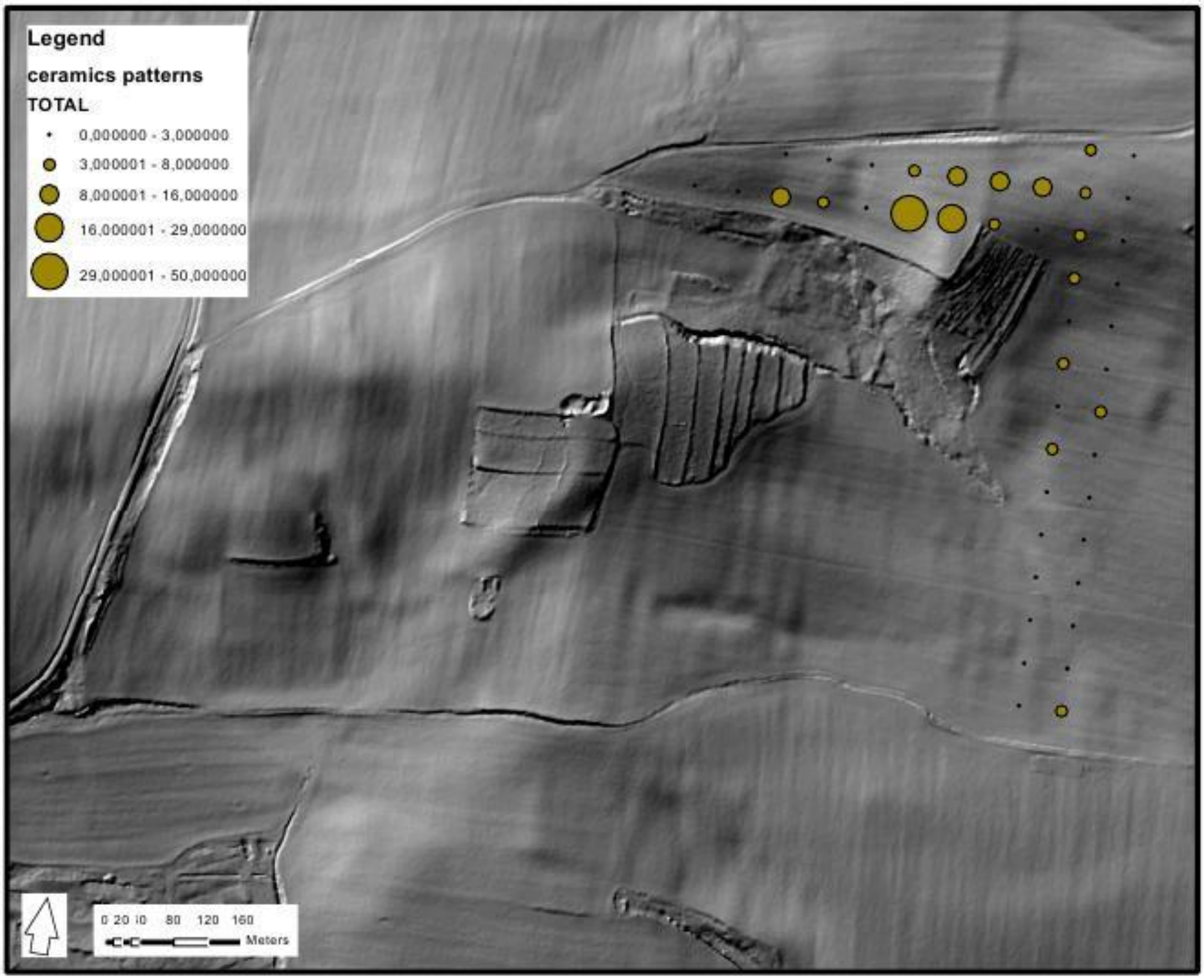


Fig. 24. Pšov A polygon. A narrow strip of finds between the field road and a small patch of forest can be observed. In this forest patch a newly discovered well-preserved remains of the field system from the 19th century can be spotted. Map background layer: shaded relief model.

Fig. 25. Pšov A area. The top image shows the well-preserved system of fields from the 19th century. Map background layer: shaded relief model. The bottom image is a ortophotomap from 2019, showing the present-day wood in this area. Image credit: google.com/maps.

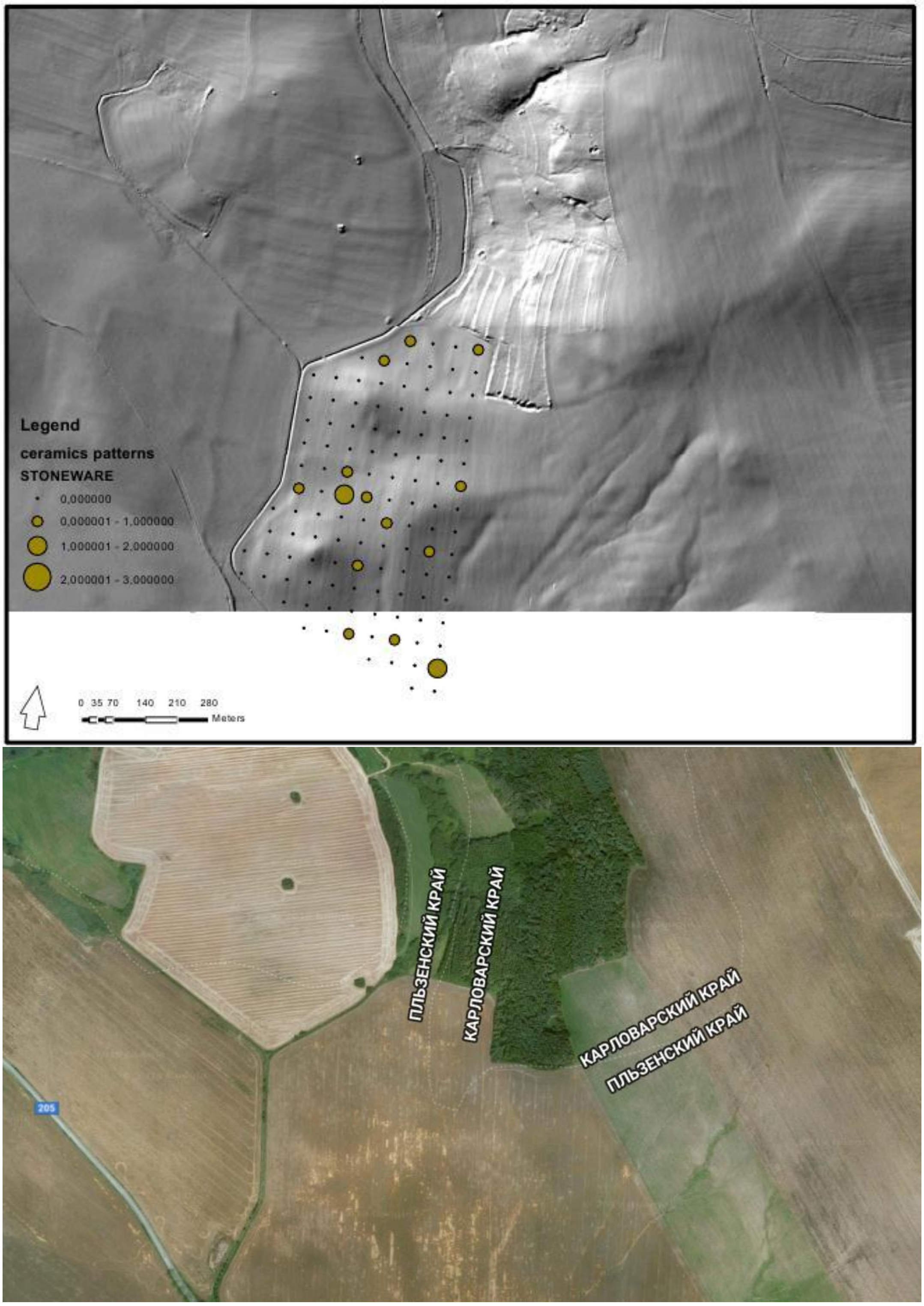


Fig. 26. Stvolny A area. The top image shows the well-preserved system of fields from the 19th century. Map layer – shaded relief model. The bottom image is a ortophotomap from 2019, showing the present-day wood in this area. Image credit: google.com/maps.

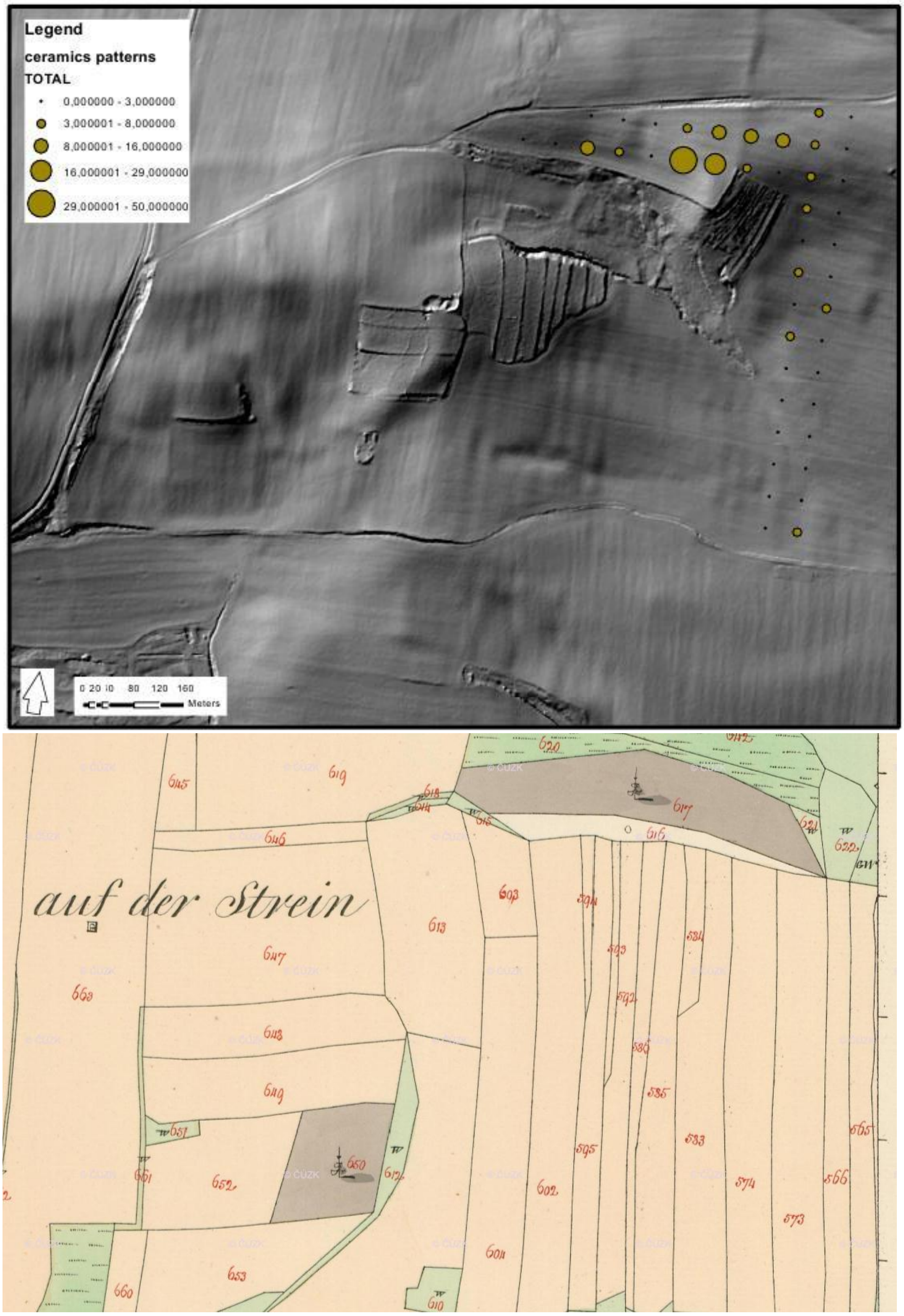


Fig. 27. Pšov A area. The left hand image is a shaded relief model where field boundaries appear clearly. The right hand image is an extract from the Stable cadaster (1841) map showing the same area. Image credit: archivnimapy.cuzk.cz.

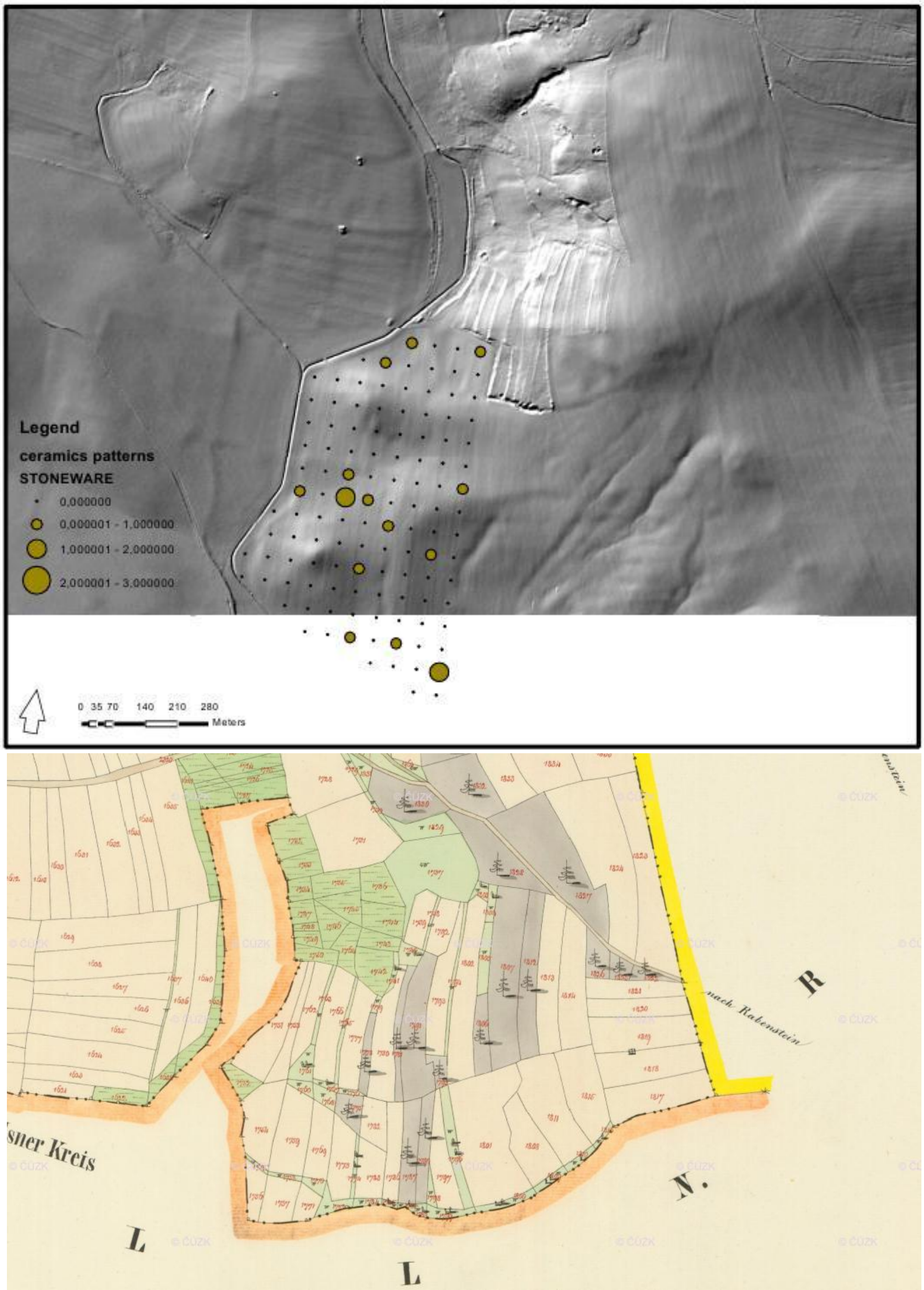


Fig. 28. Stvolny A area. The left hand image is a shaded relief model where field boundaries appear clearly. The right hand image is the extract from the Stable cadaster (1841) map showing the same area. Image credit: archivnimapy.cuzk.cz.

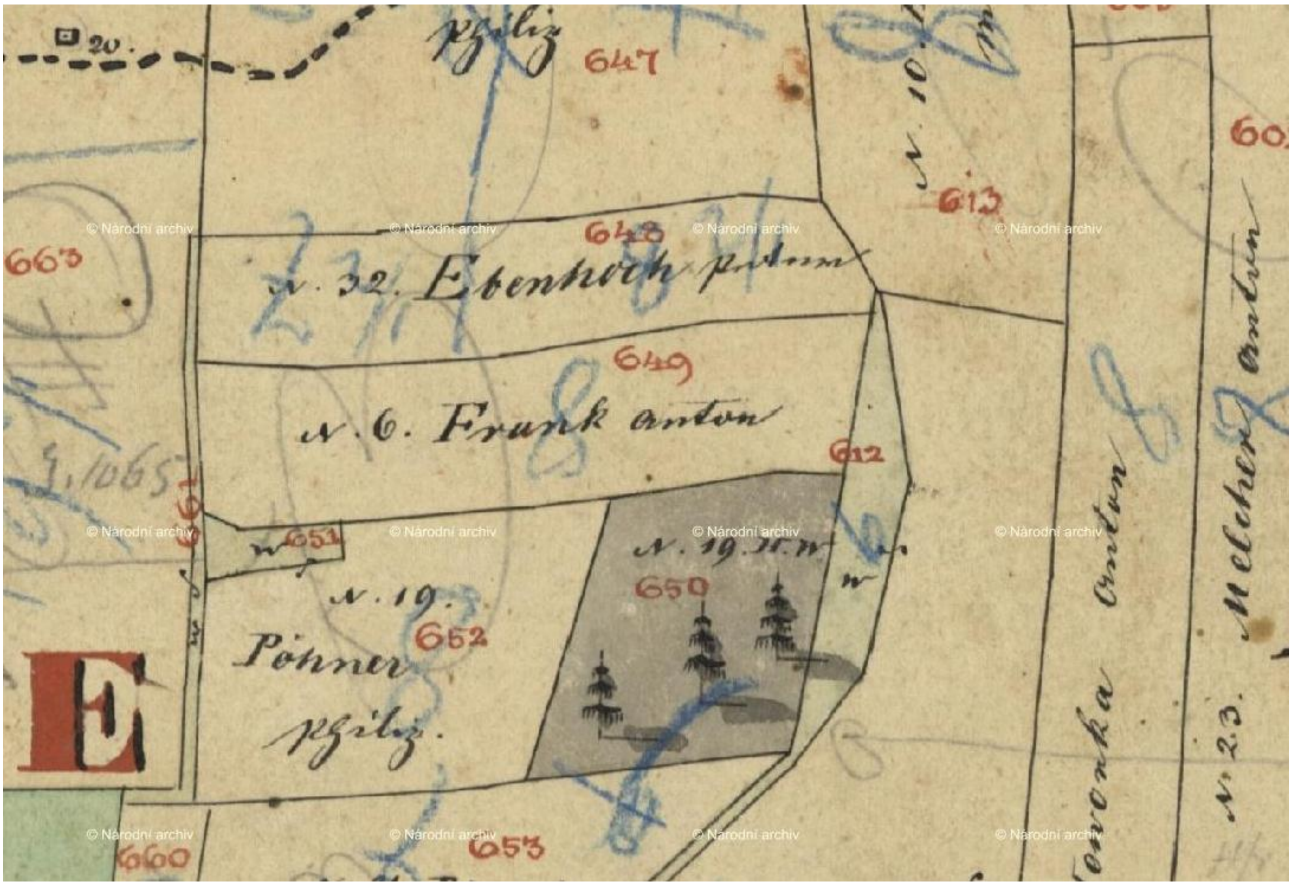


Fig. 29. Pšov A area. Extract from the map of the Indication sketch to the Stable Cadaster (1841), illustrating the beginning of transformation process of arable land into a compact patch of wood on the field parcel No. 19. Image credit: archivnimapy.cuzk.cz.

Fig. 30. Pšov A area. The shape of modern forest fully (top image) respects and preserves the shape of field parcels from the 19th century (No. 19, 6 and 32) (bottom image). Image credit: google.com/maps/, archivnimapy.cuzk.cz.